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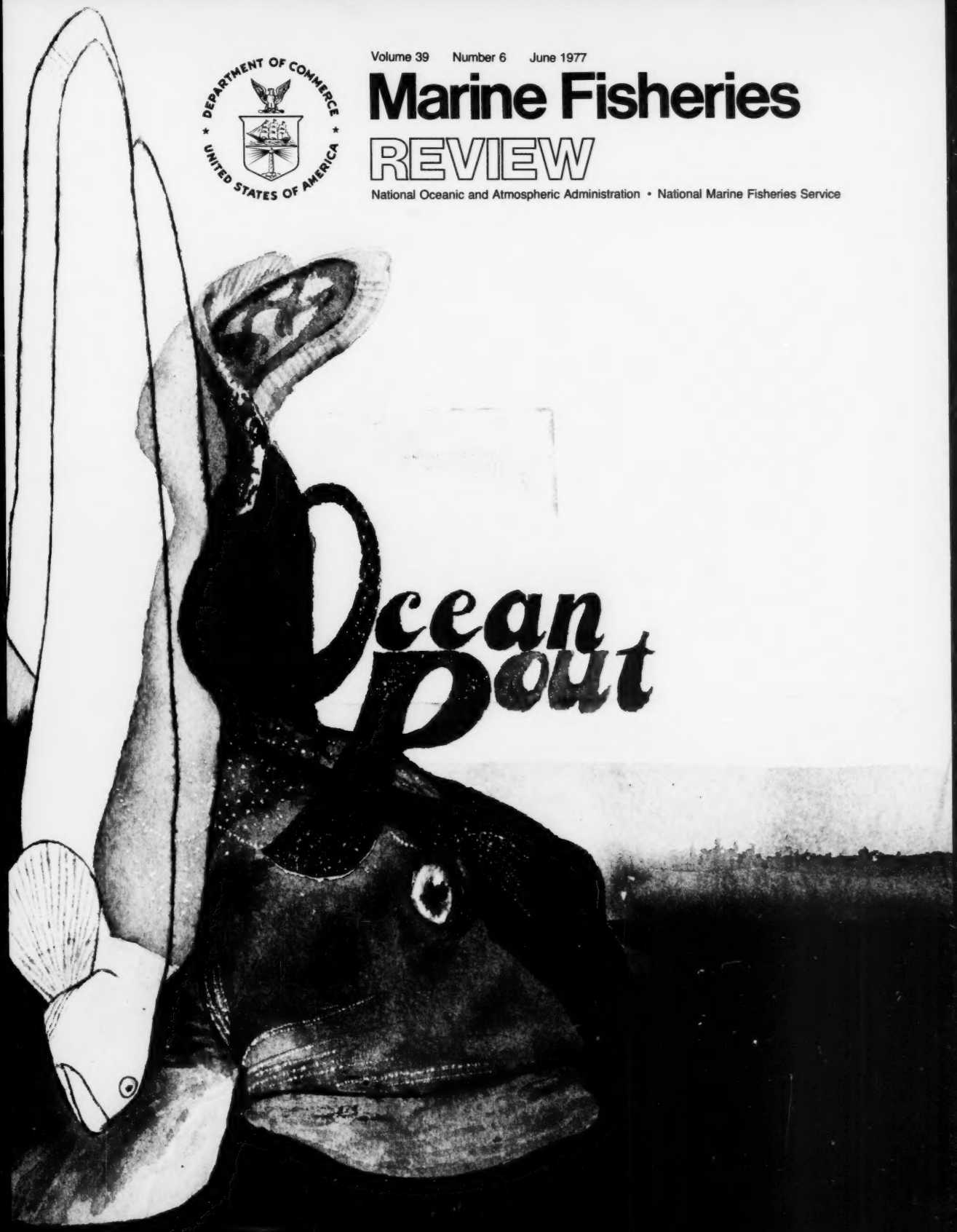

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MFR PAPER 1251

Modified Tuna Purse Seine Net Achieves Record Low Porpoise Kill Rate

JAMES M. COE and PHILIPPE J. VERGNE

Earlier this year the Southwest Fisheries Center (SWFC) of the National Marine Fisheries Service (NMFS), La Jolla, Calif., released a gear research cruise report which described results of one of the latest efforts in the NMFS program to develop gear and techniques designed to reduce porpoise mortality in commercial tuna purse seining operations. The following information, taken from this cruise report, was prepared by James M. Coe, Fishery Biologist, SWFC, and Philippe Vergne of the Porpoise Rescue Foundation.

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The cruise described in this report extended from 7 October 1976 to 9 December 1976. The area involved was the yellowfin tuna fishing grounds off Mexico and Central America within the Inter-American Tropical Tuna Commission's yellowfin regulatory area.

VESSEL AND EQUIPMENT

The tuna purse seiner MV *Elizabeth C. J.* was chartered for this cruise, with Nicholas L. Lavalouis as master, Manuel Jorge, fish captain, and Joe Jorge, alternate fish captain. The vessel, 252 feet long with a 42-foot beam and a draft of 21 feet, can carry up to 1,700 tons of frozen tuna in 10 pairs of brine wells. Propulsion is provided by a twin-screw system with two 2,800-horsepower main engines giving a top cruising speed of 18 knots; a 400-horsepower bow thruster aids in maneuverability. The net used during the cruise was 700 fathoms long by 13 standard 4¼-inch mesh strips deep. The experimental "super apron" and double-depth safety panel of 1¼-inch mesh webbing (Fig. 1) were installed in the backdown area of the net.

PURPOSE AND OBJECTIVES

Purpose of the cruise was to test a modification of the "Bold Contender" system, termed the "super apron," and to develop techniques for its efficient use in reducing incidental porpoise mortality during commercial tuna purse seining operations. This work was done in partial conjunction with tuna-porpoise behavioral studies made during a portion of the same cruise period.

In addition to evaluating the effectiveness of the "super apron" modification of the "Bold Contender" system in reducing incidental porpoise mortality, other objectives of the cruise were: 1) to adjust flotation and deployment techniques during backdown to reduce the incidence of a prematurely submerged corkline and the resultant accidental loss of fish; 2) to adjust flotation and apron structure to permit controlled sinking of the backdown apex; and 3) to conduct further tests of the use of a small, one-man inflatable raft to assist in porpoise removal during and after backdown.

RESULTS

During the cruise, 30,233 porpoise were captured and 915.5 tons of yellowfin tuna were taken in 45 net sets on

Figure 1.—"Super apron" modification of the "Bold Contender" system, 16 December 1976, assembly diagram (vertical distances not to scale).

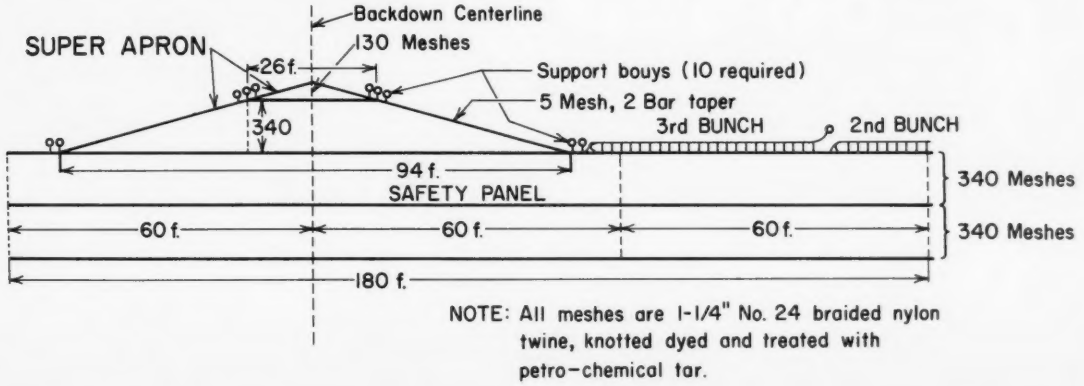

Table 1.—Data summary.

No. sets	Reason segregated	Tons tuna	Porpoise caught	Porpoise mortality	Kill per ton	Kill per set	Captured porpoise (percent) killed
15	Behavioral experiment	361.0	8,592	12	0.03	0.80	0.13
26	Gear-experimental sets without gear malfunction	492.5	19,512	4	0.008	0.15	0.02
5	Gear-experimental sets with gear malfunction	62.0	2,129	0	0	0	0
2	Schoolfish sets	95.0	—	—	—	—	—
48		1,010.5	30,233				

[1]Includes 5 tons skipjack tuna.

Table 2.—Set data.

Set no.	Exp. set no.	Date	Lat. (N)	Long. (W)	Average crew est. of porp. caught	% spin. in porp. caught	Tons[1] YF	Speed-boats used to tow	Elapsed back-down time (min)	# Raft rescued during back-down	# Porp. live in net after back-down	# Raft rescued after back-down	Spotter killed	East. spinner killed	White-belly spinner killed	Other killed	Total killed
1		10-14	18°32′	113°55′	533	—	45	0	20	3	0	0	0	0	0	0	0
2		10-14	18°27′	113°52′	325	—	35	1	8	2	0	0	0	0	0	0	0
3	1	10-16	11°19′	113°02′	water set	—	0										
4	2	10-17	10°33′	109°25′	1,350	13	65	0	16	5	1	1	6	1	0	0	7
5	3	10-18	11°15′	109°25′	950	3	25	0	20	0	0	0	1	0	0	0	1
6		10-19	10°45′	109°00′	275	—	12	0	20	0	0	0	0	0	0	0	0
7	9	10-20	10°25′	108°38′	350	1	15	0	9	1	0	0	0	0	0	0	0
8		10-20	10°22′	108°49′	975	30	25	0	13	0	0	0	0	0	0	0	0
9		10-23	10°52′	107°42′	175	—	5	0	14	0	0	0	0	0	0	0	0
10	6	10-25	9°33′	104°46′	213	—	10	0	25	0	0	0	0	0	0	0	0
11	7	10-26	9°14′	105°16′	1,066	10	70	0	19	8	0	0	0	0	0	0	0
12	8	10-27	9°21′	105°38′	183	—	18	2	9	3	0	0	4	0	0	0	4
13	4	10-27	9°46′	105°47′	1,033	17	65	2	10	5	0	0	0	0	0	0	0
14	5	10-28	9°45′	105°03′	300	—	8	0	11	3	0	0	0	0	0	0	0
15	10	10-29	9°44′	104°37′	1,000	12	55	0	11	2	0	0	0	0	0	0	0
16		10-30	9°41′	104°40′	125	—	15	0	11	3	0	0	0	0	0	0	0
17	11	10-31	9°37′	107°22′	90	—	4	2	10	4	1	1	0	0	0	0	0
18	12	10-31	9°46′	107°54′	625	45	6	2	8	3	0	0	0	0	0	0	0
19	13	11-1	10°36′	107°52′	816	1	8	1	8	0	0	0	0	0	0	0	0
20		11-1	10°43′	109°06′	1,066	6	30	1	17	0	0	0	0	0	0	0	0
21	14	11-2	10°40′	109°27′	283	—	8	1	9	4	0	0	0	0	0	0	0
22		11-2	11°27′	109°50′	766	—	8	0	26	2	4	3	0	0	0	1	1
23		11-4	18°21′	113°23′	866	78	10	1	16	5	0	0	0	0	0	0	0
24		11-4	18°34′	113°54′	933	5	50	0	7	5	0	0	0	0	0	0	0
25		11-5	18°40′	113°30′	1,033	13	20	1	15	7	0	0	0	0	0	0	0
26		11-5	18°23′	113°30′	683	15	5	1	20	0	0	0	0	0	0	0	0
27		11-9	13°53′	104°21′	683	—	10	0	11	6	0	0	0	0	0	0	0
28		11-11	13°58′	101°35′	833	—	12	0	15	10	0	0	0	0	0	0	0
29		11-11	14°14′	101°34′	683	0	9	1	13	5	0	0	0	0	0	0	0
30	15	11-12	13°43′	101°39′	333	0	4	0	15	3	0	0	0	0	0	0	0
31		11-12	13°34′	101°28′	55	0	0	0	6	1	0	0	0	0	0	0	0
32		11-13	12°20′	102°51′	700	0	4	0	12	5	0	0	0	0	0	0	
33		11-15	9°15′	100°18′	Sch. F	—	0										
34		11-16	9°20′	98°20′	266	—	45	1	10	4	0	0	0	0	0	0	0
35		11-16	9°08′	98°03′	433	—	12	1	8	2	0	0	0	0	0	0	0
36		11-18	10°15′	98°09′	Sch. F	—	90										
37		11-19	10°01′	97°31′	86	—	25	1	8	1	0	0	0	0	0	0	0
38		11-19	9°36′	97°15′	316	—	14	0	10	3	0	0	0	0	0	0	0
39		11-20	9°18′	97°50′	106	—	10	0	6	2	0	0	0	0	0	0	0
40		11-21	9°27′	97°46′	1,400	—	35	1	12	3	0	0	0	0	0	0	0
41		11-21	9°42′	97°44′	266	—	16	1	13	0	0	0	0	0	0	0	0
42		11-21	9°45′	97°54′	300	—	7	1	12	2	0	0	0	0	0	0	0
43		11-23	15°30′	101°27′	1,233	65	12	0	16	15	0	0	1	2	0	0	3
44		11-26	19°38′	111°21′	800	—	15	0	17	5	0	0	0	0	0	0	0
45		11-27	18°21′	114°18′	233	5	10	0	24	7	0	0	0	0	0	0	0
46		12-2	10°52′	109°53′	2,500	5	32	0	12	3	0	0	0	0	0	0	0
47		12-5	19°13′	111°49′	550	—	25	0	15	4	0	0	0	0	0	0	0
48		12-6	18°55′	112°50′	1,666	95	1.5	0	15	0	0	0	0	0	0	0	0
Total (behavior sets)					8,592		361	10	180 (Avg. 12.86)	41	2	2	11	1	0	0	12
Total (gear sets)					20,864		644.5	12	422 (Avg. 13.61)	105	4	3	1	2	0	1	4
Total (all sets)					29,456		1,005.5	22	602 (Avg. 13.38)	146	6	5	12	3	0	1	16

[1]Tonnages are estimates made at time of set, not actual unloading weights.

yellowfin tuna associated with porpoise. One set was a water set and two sets were made on tuna associated with floating objects (logs) in which 90 tons of yellowfin and 5 tons of skipjack tuna were landed. Table 1 presents a summary of the catch and kill data for the behavioral research and gear research sets. Table 2 presents the date, location, catch, kill, and raft-use statistics by set with subtotals for the gear and behavioral sets.

Porpoise mortality occurred on only 5 of 45 sets made on tuna-porpoise-associated schools. Sixteen porpoises were killed on these 5 sets—4 during the course of regular fishing operations and 12 during the activities of the scientific party. Excluding mortality during scientific activity, the mortality rates were 0.09 per set, 0.004 per ton of yellowfin caught in association with porpoise, and 0.013 percent of the porpoise captured.

Fourteen net sets were made for the purpose of studying porpoise behavior in detail. As many as three skiffs and six divers were inside the net prior to and during backdown. In three of these sets (numbers 4, 5, and 12) the presence of the divers and tagging efforts during backdown hampered porpoise release and resulted in 12 of the 16 deaths. The remaining four deaths occurred during backdown in two gear experimental sets that had no operational malfunctions. The animals became folded into the side of the backdown channel at a depth that precluded hand rescue.

The extremely low porpoise mortality rate experienced during this cruise was the result of the care and efficiency of the fishing captain and crew members in setting and hauling their net, using speedboats to adjust the corkline (18 sets), and in backing down until all live porpoise were released (42 of 45 sets). These efforts, in conjunction with the "super apron" and double-depth safety panel of 1¼-inch stretch-mesh webbing, allowed this vessel to achieve a record low kill rate.

The "Super Apron"

The apron-type appendage to the backdown area of purse seine nets was first tried on an NMFS-chartered vessel in the fall of 1974 and subsequently led to the development and successful testing of the apron-chute complex known as the "Bold Contender" system, 1 year later. It includes a porpoise safety panel of 1¼-inch mesh webbing 12 fathoms deep and 180 fathoms long. A 10-vessel mass test of the "Bold Contender" system in 1976 resulted in mortality rates substantially below the 1976 fleet averages for vessels using conventional nets, i.e., 2-inch stretch mesh in the safety panel. However, the mass testing revealed two generally recognized problems with its use. First, the smaller mesh size of the safety panel and apron-chute complex caused considerably greater drag when being pulled through the water during backdown than did the normal 2-inch safety panel. This caused the corkline perimeter of the backdown channel to submerge in the early stages of backdown, thus increasing the danger of loss of fish and necessitating a slower-than-normal backdown. Secondly, several vessels reported that the inability to sink the corkline at the apex of the backdown channel in the later stages of the procedure caused greatly increased need for hand rescue and longer backdown times.

To alleviate these problems, the two-stage taper employed in the "Bold Contender" system (five mesh, two bar on the apron and one mesh, two bar on the chute) was changed to all five mesh, two bar. This straight taper allowed more even distribution of the downward pull on the corkline as backdown proceeded. Although the corklines did tend to sink slightly in the early stages of backdown, and backdown still had to begin slowly, no fish were lost at this stage during the charter and it was generally agreed that there was no problem.

With the "super apron" modification, the topmost strip of 1¼-inch webbing (designated as the chute in the "Bold Contender" system) is approximately 200 meshes shallower at the backdown apex than its predecessor. The fish captain was able to sink the backdown apex to release the porpoise at will during all stages of the procedure. The resurfacing of the corkline after sinking was probably slightly slower than for nets with the 2-inch porpoise safety panel. Two or three speedboats were deployed at the backdown channel apex on every set to help prevent accidental fish loss and to hand-release porpoise as needed. The chief scientist estimated that approximately 18 tons of tuna were accidentally backed out of the net during porpoise release in the 45 porpoise sets during the cruise. In general, the fish captain and the alternate fish captain were pleased with the porpoise-saving characteristics of the "super apron."

Observations from the inflatable raft during backdown on the charter of the MV *Bold Contender* (fall 1975) showed that spotted porpoise sometimes became passive and piled up on the bottom of the backdown channel where they could be mistaken for dead. The removal of the extra webbing in the chute (discussed above) eliminated the two-step shelf formed with the "Bold Contender" system. Thus, as backdown proceeded with the "super apron," the channel became progressively shallower and ramp-like, raising the "passive" spotters up and flushing them out of the net. This reduced the necessity for hand rescue considerably. Of the 146 animals hand-released from the raft during backdown, the rescuer was quite certain that most of them would have been backed out anyway. No porpoise were killed in the six porpoise sets for which the raft was not used.

The use of the "super apron" atop the small-mesh, double-depth safety panel is not without operational faults, primarily because of the increased drag of the small mesh as it is moved through the water or as it is held against a current. In each of the porpoise sets which caught 50 tons of tuna or more the corkline tended to sink after backdown in the area just outboard of the third bow bunch. Though only a few tons of tuna were lost in porpoise sets, approximately 35 tons were lost in set 36 (schoolfish on a log) in this area. Underwater observation of the net in that area showed that as the net is hauled in after backdown the small mesh squeezes the entrapped water against

the bunches which act as a dam. The blocked water forces the small mesh outboard of the third bow bunch to canopy out and when stretched to its limit the corkline begins to sink. The faster the net was rolled the more rapidly water had to be squeezed out and the deeper the corkline sank. It was found that this kind of sinking could be alleviated easily by release of the third and second bunches slightly earlier than normal. With large catches (>50 tons) it may be necessary to roll the net aboard a little more slowly.

On set 33 (schoolfish with a log) a very strong surface current and an oblique subsurface current caused the entire area of small mesh from the second bow bunch to mid-net to sink and stay down until the purse rings were brought up out of the deep current. The surface current moved the log and almost all of the fish over the sunken corkline. It was not possible to judge the degree to which the small mesh was responsible for the sinking but it surely contributed to it. To avoid this problem in areas of strong currents, the captain must note the current direction and position all sets to avoid pursing the small mesh area of his net against the current.

As with the "Bold Contender" system, there is a tendency for the center of the "super apron" to fold into or out of the net in some sets. On 15 sets a speedboat was used without incident to open or adjust the backdown apex prior to backdown. No maintenance was required on the small mesh during the cruise and only a few broken meshes and shark holes were seen by the underwater observer.

Inflatable Raft

During 39 of 45 porpoise sets, a small inflatable raft was used as an observation-and-rescue platform by one of the scientists employing a mask and snorkel. The raftman signaled the captain when the backdown release area was clear of fish. In addition, he assisted in the removal of the last few porpoise in the late stages of backdown. Generally, backdown was continued until the raftman signaled that all porpoise including the "passive" spotters had been released.

In checking to see if all live porpoise were out of the net, it was discovered that the raftman could hear vocalizations of porpoise that were still in the net but could not be seen. This final listening check became common practice and several animals were saved as a result.

The raft was also used during backdown to herd the porpoise toward the release area. This seemed to work well but only if the raft stayed more than about 10 meters from the nearest animals. When some groups of porpoise (10 to 100) would refuse to go over the corkline during backdown the raftman would wait until they were congregated near the sunken corkline and then paddle straight at them making as much commotion as possible. The initial avoidance response of the nearest animals often started them over the corkline and backdown would proceed to completion.

In four sets with expected large catches of fish the raft was used to attach up to four flotation balloons to the corkline along the sides of the backdown apex to lessen the chance of fish loss if all of the fish happened to move into the apex at one time. This was probably a good safeguard but it was never really tested with a large catch. After backdown the balloons were collected in the raft to facilitate net retrieval.

SUMMARY

The record low mortality rate experienced on the charter cruise is the result of the concurrent evolution of improved fishing techniques and gear modifications developed by NMFS and the tuna industry and increased awareness of the captain and crew of the necessity to reduce incidental porpoise mortality. The following general list summarizes the activities which allowed the low mortality rate.

1) Set positioning to minimize negative effects of wind and current.

2) Early recognition of potential net collapse areas and use of speedboat(s) to prevent collapse.

3) Use of speedboats to herd porpoise out of potential danger areas.

4) Use of speedboats to adjust backdown area corkline prior to backdown.

5) Consistent use of two or three speedboats at backdown apex to prevent fish loss and to rescue porpoise.

6) Consistent backing down until all live porpoise are out of the net (very important).

7) Use of person in inflatable raft to:

a) Signal when backdown apex is clear of fish;

b) herd and hold the porpoise in the backdown apex;

c) determine by using a mask and snorkel and by listening, when all live porpoise are out of the net; and

d) hand-releasing animals.

8) Incorporation of small-mesh, double-depth safety panel.

9) Incorporation of "super-apron."

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MFR PAPER 1252

The Ocean Pout: An Example of Underutilized Fisheries Resource Development

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SAUL B. SAILA, and SPIROS M. CONSTANTINIDES

ABSTRACT–The results of a coordinated research and development effort, which addressed the biological, processing, and marketing problems involved in the development of a food fishery for ocean pout, are described. Fishery investigations indicated that the ocean pout is a substantial resource in southern New England waters, and suggest that there are unit stocks which experience little mixing. The combination of a relatively slow growth rate and a low fecundity make careful monitoring and stock management essential to the continued growth of this fishery. Chemical analysis and taste panel evaluation demonstrated that ocean pout is a lean fish, low in cholesterol content, and is highly acceptable to the U.S. consumer. Lesion occurrence was about 6 percent (for fillets) and candling is considered essential to insure a high quality product. Marketing efforts which concentrated on a fresh fillet product have met with considerable success at both the retail and wholesale level. While only small amounts of pout for human consumption were landed in previous years, the 1976 landings in Pt. Judith, R.I., alone approximated 1 million pounds. An extensive marketing program has been successful in expanding the marketing area and in significantly increasing sales volume.

INTRODUCTION

Due to the intense fishing pressure on species in the northeast Atlantic region traditionally consumed by the public, the majority of these stocks are currently exploited near or beyond their sustainable yield levels (Rathjen, 1974). It has been suggested that one of the most promising strategies to revitalize and strengthen the U.S. fishing industry is through the development of underutilized fishery resources (Government Accounting Office, 1975). Ocean pout, *Macrozoarces americanus*, which make up about 35 percent (by weight) of the industrial ground fish landed in southern New England and 46 percent of that landed in the Middle Atlantic States (Holmsen, 1973), is a prime example of an underutilized resource. While only 14×10^6 pounds were landed in both regions commercially in 1973, recent investigations (Orach-Meza, 1975) suggest the maximum sustainable yield (MSY) may be as high as 72×10^6 pounds in the region of its geographic distribution.

Previous efforts to market ocean pout as a food fish were conducted during 1943 and 1944 as a result of the war conditions (Olsen and Merriman, 1946). The incidence of parasitic lesions and a concomitant public health embargo caused ocean pout to be relegated to a trash fish. Recent investigations (Sheehy et al., 1974) reexamined the incidence and distribution of the lesions and suggested that proper candling of fillets together with improved

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processing practices could serve to reinstate ocean pout as a food fish.

The current situation of declining coastal fish stocks, increased prices for imported fishery products, and forthcoming implementation of the 200-mile zone of economic jurisdiction serve to focus attention on the need for rational and efficient use of our available fishery resources. It is the purpose of this paper to describe a coordinated effort by fishery, food science, processing, and marketing staffs at the University of Rhode Island (URI), in cooperation with commercial interests, to develop the ocean pout fishery.

FISHERY INVESTIGATIONS

Methods and Materials

A tagging study was initiated in order to determine the growth and movements of ocean pout found at one specific site. Survey trawling, begun in early March 1975, was conducted in several areas of Block Island and Rhode Island sounds in order to locate a concentration of ocean pout that was dense enough for efficient tagging (Fig. 1). Small numbers of ocean pout were encountered off Charlestown, R.I. (A), the "east edge of the southwest grounds" (B), and "the Torpedo Range" (C). High concentrations were found east of Sandy Point, Block Island, in the area known as "Cow Cove" (D), and this site was selected for the tagging study.

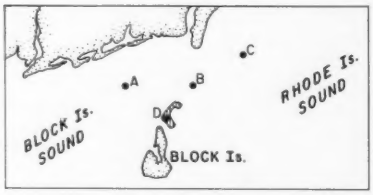


Figure 1.—Sampling locations in Block Island and Rhode Island sounds.

A total of 3,000 fish were collected and tagged. With the exception of 86 fish tagged off Charlestown, all were collected on identical 75-minute trawls in Cow Cove made during the period of 5 March to 11 April 1975.

The RV *Dulcinea*, a 13-m trawler equipped with a scaled down "Yankee 35" trawl net was used for the study. The net had a spread of about 6.1 m and lifted about 1.2 m off the bottom. The wings were fabricated of 10.2-cm mesh, and a 8.8-cm mesh bag liner was used to retain small specimens.

A numbered yellow dart tag 9 cm long bearing the legend "Reward-GSO 21 URI" was used. The tag was inserted in the dorsal musculature somewhat anterior to the midpoint of the fish on the left side (Fig. 2). The last 100 fish were also tagged with a yellow Peterson disk tag (2.5-cm diameter) in order to get a field estimate of tag loss. The Peterson tags were applied through the dorsal musculature just posterior to the dart tag.

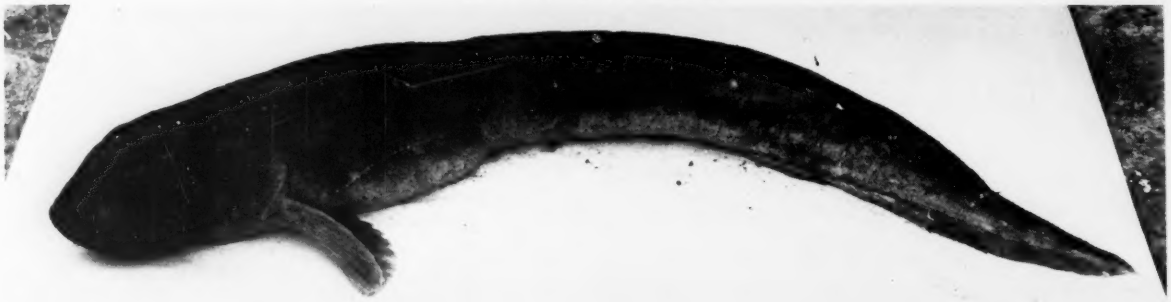
Quinaldine was used as an anesthetic during tagging. It was mixed with an equal portion of acetone and diluted to a concentration of 1 part per 300,000. With this dosage, immobilization occurred in about 7 minutes, at which point the fish were tagged and measured to the nearest millimeter. Recovery time was about 15 minutes and fish were then returned to the sea in the same area in which they were captured.

Laboratory tests were undertaken in order to estimate tag retention and tagging mortality. On 18 March 1975, 100 fish selected from the catch by using a table of random numbers were anesthetized, measured, and tagged at sea in the normal manner. The fish were then transported in a fiberglass tank equipped with air and running seawater to the Marine Experiment Station, Rhode Island, and placed in four 535-liter running seawater tanks. This experiment was terminated on 19 May when a breakdown in the seawater system caused some mortality. The fish were then sacrificed to determine the sex ratio in the 18 March 1975 catch.

A $5.00 reward was offered for the return of tagged fish. Reward posters were widely distributed from Canada to New Jersey with the assistance of the Point Judith Fisherman's Cooperative, National Marine Fisheries Service (NMFS) port agents, bait shops, charter boat captains, Marine Advisory Service agents, and personal communication with local fishermen. Publicity generated by the other aspects of the project also included a reference to the tagging program.

A series of eight survey scuba dives were conducted at several sites near Cow Cove during the period of May to August 1975 to determine if ocean pout remained in the area during the summer months. Rocky areas not vulnerable to commercial trawling were chosen. The sites ranged from a depth of 12 - 34 m and were monitored on a biweekly basis.

Figure 2.—Ocean pout with dart tag.



All fish returned via commercial trawlers during both 1975 and 1976 were examined and sexed when possible. In addition a random sample for sex determination was taken from the RV *Dulcinea* catch on 15 April 1975 and 22 March 1976.

Results and Discussion

Movement

At the end of the first season, 1 June 1975, a total of 247 tagged ocean pout were recovered. One hundred and twenty-five of these fish were recovered during the later phases of the tagging operation in Cow Cove. The tag numbers of these fish were recorded and they were rereleased. In addition, 122 fish were recovered after 11 April when tagging operations were complete: 120 by local commercial trawlers, 1 by a sport fisherman, and 1 from a lobster trap. Ninety-six percent of these 122 recaptures occurred before 15 May 1975 and were within 2 nautical miles of Cow Cove, indicating little movement during the fishing season. Some of the later (after 15 May 1975) returns seemed to indicate some small scale dispersion from the Cow Cove area, mostly to the northeast. However, these returns were few in number and no significant conclusions can be drawn.

Divers observed some ocean pout in the rocky areas near Cow Cove through mid-June 1975. These later surveys recorded ocean pout only in the deeper areas (>25 m). Ocean pout were observed under rocks and in depressions in the sand. While actual sightings were few in number, ocean pout were present in nearby areas later in the season than they occurred in inshore commercial trawl catches. No pout were observed in Cow Cove trawls after late May and none were observed by divers after July 1975.

Oviatt (pers. commun.) reported that ocean pout were observed during submersible dives 9 miles SE of Block Island in 93 m during dives in June, July, and October 1970. The pout were observed around collections of scallop shells and near boulders on a fine sandy bottom. In addition juvenile pout 7.6 cm in length and less were seen inside a number of scallop shells. Sheehy (1975, 1976) has noted that ocean pout have occupied artificial lobster shelters in the Charlestown and Block Island areas into late May.

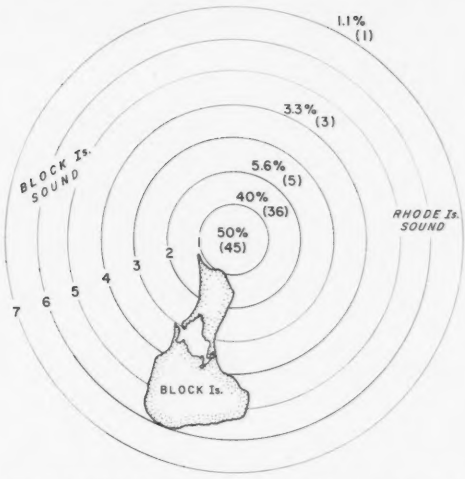


Figure 3.—1976 tag returns. Percent and number ( ) fish returned; concentric circles are nautical miles.

Returns of tagged ocean pout during the 1976 season began in early February and continued through mid-May. Again, the majority of the 106 tagged fish returned were caught by commercial trawlers operating in or near Cow Cove. Figure 3 shows the distribution of returns around the original tagging site. Ninety percent of the recovered fish were captured within 2 nautical miles of the tag point and none were recovered more than 8 miles away.

Results demonstrate little long-term movement of ocean pout during the 1-year period. This supports studies done by Orach-Meza (1975) using meristic and morphometric variations, which suggested that distinct unit stocks of ocean pout existed with little apparent mixing. While the whereabouts of ocean pout during the period from June to December is still not completely clear, it seems likely that they make local movements to deeper water in areas not vulnerable to trawling due to rocks and boulders.

Growth, Size, and Sex Composition

Ninety-six of the fish returned during 1976 were useable for growth calculations. A computer program developed by Fabens (1965) was utilized to fit the von Bertalanffy (1960) growth curve to the size at recapture data in order to establish the rate of growth. This program takes advantage of the special properties of the exponential growth curve which permits k (a measure of the intrinsic growth rate) and a (asymptotic length) to be determined from data only on sizes at known time differences with no knowledge of absolute age. The parameter b (which is related to the size of the fish at birth) cannot be estimated from recapture observations alone and some observations of sizes at known ages must be supplied to determine b. This program computes the parameters k and a by an iterative least squares technique and then accepts additional data to compute the parameter b. The average estimated sizes at birth, 6 months, and 1 year (3.0, 6.5, and 13.2 cm, respectively) used in this study were based on Olsen and Merriman's (1946) study. The growth curve resulting from this analysis is presented in Figure 4. The computed values of the parameters are $a = 69.3$ cm, $k = 3.43 \times 10^{-1}$, and $b = 0.95$ cm.

The results indicate a relatively slow growth rate for ocean pout from Rhode Island waters. The mean lengths by age differ significantly from those reported previously by Sheehy et al. (1974), Draganik and Zukowski (1966), and Olsen and Merriman (1946) but compared favorably with the work of Clemens and Clemens (1921). All of these

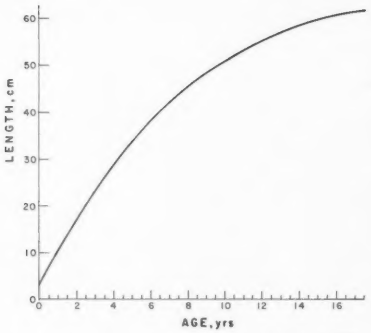


Figure 4.—Rate of growth of *Macrozoarces americanus* from tag return data.

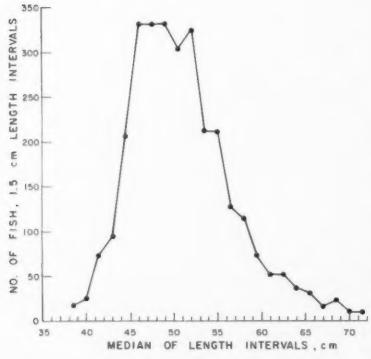


Figure 5.—Length frequency plot of tagged ocean pout, *Macrozoarces americanus*.

other studies were based on age determinations made by otolith analysis which are subject to some variation in the interpretation of the central kernal. The variation may also be attributable to geographic (Draganik and Zukowski, 1966) and/or temporal (Olsen and Merriman, 1946) differences in the rate of growth as well as to the influence of variable fishing pressure.

The length data on the original 3000 fish tagged was used in the BMD 05D General Plot Computer Program (Dixon, 1974) to construct the length frequency plot presented in Figure 5. The results indicate that the bulk of the catch is between 43 and 60 cm in length. The plot is slightly positively skewed. Based on the growth curve in Figure 4 this would indicate that most of the catch is composed of individuals between 7.5 and 16 years old.

Table 1 presents the sex composition of samples in Rhode Island waters from various sources. The samples taken on

Table 1.—Ocean pout sex ratios.

Sample date(s)	Sample size	Males	Females	% males in sample
Feb. and Mar. 1976	531	241	290	45
15 Apr. 1975	401	185	216	46
19 Apr. 1975	120	55	65	46
22 Mar. 1976	67	31	36	46
all 1976 returns[1]	61	18	43	30

[1]All returns which could be sexed.

15 April 1975 and 22 March 1976 were selected at random from the catch taken from Cow Cove by the RV *Dulcinea*. The 19 April 1975 sample was selected at random from the catch taken from Cow Cove by the FV *Two Brothers*. The 1972 data was taken from a previous study (Sheehy et al., 1974). The 1976 returns are the sum of all tagged fish returned during 1976 from which the sex could be determined. All samples were taken with trawls which had a 3.8 cm bag liner. The data indicate a slight preponderance of females which is consistent over all samples except for the 1976 returns. This slight preponderance of females may be due to the increase in girth of these females due to egg development which would cause a greater number of smaller females to be retained in the mesh of the net. Females may thus be vulnerable to fishing effort for a longer period.

Tag Mortality and Retention

Laboratory tag loss and mortality studies indicated that ocean pout were quite hardy. No mortality attributable to handling or tagging was experienced. A 5 percent tag loss appeared to be primarily the result of feeding activity and abrasion on tank fixtures. Several tags were observed while being pulled out by other fish during daily feeding.

The returns of those fish which were originally doubly tagged are presented in Table 2. The returns are broken down by year and by whether or not a tag was missing, as well as by indications as to the relative age of scars. While only 3.3 percent of the tagged fish had double tags, almost 15 percent of the fish returned (after tagging operations were complete) were originally double-tagged. This clearly demonstrates that the addition of the Peterson tag significantly increased the probability of return. This could be due either to the increase in net retention caused by the tag or to the increased visibility of these tags. The ratio of dart tag loss to Peterson tag loss was about 3:1 for both years. Eighty percent of Peterson losses were recent (probably in capture) while 57 percent of the dart tag losses were recent. Sixty-one percent of the double-tagged fish returned had a tag missing.

Summary and Conclusions

A recent survey of available data by Orach-Meza (1975) confirmed earlier studies which indicated that ocean pout are a substantial resource off the coast of southern New England. An indirect estimate, based on studies of trawl efficiency, of the percentage of ocean pout which are discarded from the commercial and NMFS survey trawls suggests a maximum sustainable yield of about 72×10^6 pounds (Orach-Meza, 1975).

The tagging studies described in this paper support meristic and morphometric analysis (Orach-Meza, 1975) by providing evidence that there are distinct stocks of ocean pout which undergo little mixing. Apart from the seasonal movements into deeper or rocky, nontrawlable areas, there is no evidence of any large-scale movements by ocean pout.

Results of this study demonstrate that ocean pout are a relatively slow growing, long lived species in Rhode Island waters and are vulnerable to fishing effort for up to 10 years. The fact that they also have a low fecundity (Olsen and Merriman, 1946) and that females may be vulnerable longer than males strongly suggest that careful monitoring of the catch may be vital to the

Table 2.—Return of double tagged ocean pout.

		Number missing dart tag				Number missing Peterson tag				
		Scar type				Scar type				
Year	Number with both tags	Recent	Old	None	Subtotal	Recent	Old	None	Subtotal	Total
1975	10	3	0	0	3	1	0	0	1	14
1976	4	5	4	2	11	3	1	0	4	19
Total	14	8	4	2	14	4	1	0	5	33

effective management of this resource.

If a significant fishery for ocean pout develops, additional information on this species should be obtained. In particular, a direct, more accurate estimate of the biomass and MSY are recommended. In addition, efforts to more completely identify unit stocks and to define the age-fecundity relationship should be undertaken.

CHEMICAL ANALYSIS, PROCESSING AND ACCEPTABILITY

Methods and Materials

The chemical characteristics, processing time, yield, and acceptability of ocean pout for human consumption were examined.

Labor and Rate

A rate study to determine the required processing time for ocean pout was accomplished by using skilled filleters and a commercial deskinning machine normally used in deskinning flounder. No adjustment to the blades was needed to accommodate ocean pout on the deskinning machine. One operator was used to operate each machine.

A batch of about 550 kg of ocean pout was used in this study and the rates of the following steps were recorded:

1) Filleting: The process included picking up the fish from the feeding conveyor belt, filleting the two longitudinal fillets (the cut started 7.5 cm behind the head bone), delivering the fillets onto the conveyor, and discarding the waste into the waste slot. One knife sharpening period of 4-5 minutes was also included.

2) Deskinning: The work included feeding the fillet into the machine and monitoring machine operation.

Candling and Lesion Occurrence

Candling was accomplished with a specially designed candling box which used a variable intensity (22-94 W) fluorescent light source. The box was fabricated of Plexiglas[1] and had a frosted Lexan top which permitted lesions to be cut out while the fillet was on the box (Fig. 6). The unit was electrically insulated to prevent shock and could be placed directly on the conveyor line. Three boxes were made locally at the Engineering Instrument Shop at URI.

[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Figure 6.—Photograph of candling box. Finger pointing to a lesion (dark spot) in lower fillet.

Figure 7.—Commercial filleting operation.

A random sample of 204 ocean pout fillets was examined by candling to determine the average occurrence of parasitic lesions.

All ocean pout landed during the study for human consumption were candled and visible lesions were removed.

Yield

The yield, in terms of deskinned fillets, was determined both in the laboratory and on a commercial filleting run conducted at the Point Judith Fisherman's Cooperative Association in Galilee, R.I. (Fig. 7). Laboratory processing was used to determine the yield for each of the following three steps: 1) beheading and eviscerating, 2) filleting and deskinning, and 3) removal of lesions. The commercial test run was conducted to determine the normal production yield of deskinned and candled fillets which could be expected in regular processing operations.

Taste Panel Evaluations

Samples of ocean pout fillets were organoleptically evaluated through a series of taste panel tests, with flounder fillets (*Pseudopleuronectes americanus*) used as reference samples. These tests were conducted with under-

	SCALE									SAMPLE CODE		
	+4	+3	+2	+1	0	-1	-2	-3	-4			
TEXTURE	Hard				Optimum				Soft			
COLOR	Very pale Undesirable				Desirable				Very dark Undesirable			
ODOR	None		Slight		Moderate		Intense		Undesirable			
TASTE	Bland Faint Lacking the taste		Slightly desirable		Pleasant		Slightly undesirable		Very fishy Bitter Rancid Undesirable			
AFTERTASTE					No aftertaste Pleasant aftertaste				Strong Undesirable aftertaste			

Comments:

Panelist Name (or Number):

Date:

Figure 8.—Organoleptic score sheet.

graduate and graduate students of the Food and Nutritional Science Department at URI who were experienced with taste panel procedures. The recommendations for selecting panelists, performing the taste tests, and analyzing the data statistically were performed according to Larmond (1970).

Fresh fish (landed the same day) were used for all tests. Ocean pout and flounder fillets were cut into 6 × 8 cm portions, then steamed or battered and fried (according to the test procedure), and presented warm to the panelist. Each panelist received a tray with the prepared samples for his or her evaluation.

Three separate tests were conducted, with a different scoring procedure used in each. The first test was designed to determine the general acceptability of ocean pout fillets. Batter fried samples (Run A) were evaluated using a descriptive 9-point hedonic score sheet with 9 as "extremely acceptable".

In order to investigate specific characteristics of ocean pout, a special score sheet (Fig. 8) was designed for the second test. This sheet had descriptive terms accompanying numerical scores from +4 to −4, with the most desirable properties rated 0 and the extremes on either side. Steam cooked ocean pout and flounder (Run B) were tasted by 11 panelists.

A triangle test was conducted (Run C) to determine if panelists could distinguish between ocean pout and flounder. In this test each of the 11 panelists was presented twice with three samples of fish, two of which were identical and the third was different. They were then asked to distinguish which sample was different.

Chemical Analysis

Protein, moisture, and ash content of whole fish were determined according to Association of Official Analytical Chemists methods. Nonprotein nitrogen was measured as cited by Shenouda (1966). Total lipids were determined using the method of Bligh and Dyer (1959). A composite ground sample was used for each month's analysis. The sample consisted of 10-12 fresh fillets which were passed through a meat grinder three times.

Fatty acid composition was evaluated by esterifying the extracted lipids for gas liquid chromatography (GLC) according to Metcalf et al. (1966), and was separated by using an 8 ft × ⅛ in internal diameter stainless steel column packed with chromosorbe-W (80-100 mesh) and impregnated with 10 percent diethyl glycol succunate. The conditions of separation, using a Varian GLC with a hydrogen flame detector, were as reported by Hornstein et al. (1967). Standard references for fatty acid esters (Supelco Inc., Pa.) were used in identifying the fatty acids.

Total cholesterol in the fillets was determined spectrophotometrically as described by Tu et al. (1967) and modified by Wybenga et al. (1970).

Results and Discussion

Labor and Rate

The results of the processing time study were as follows: the rate recorded for the filleting operation was 160 fish/h/laborer or 150 kg/h/laborer. This filleting rate is considered exceptionally high when compared to other fish species such as flounder, 45-55 kg/laborer/h, or white fish (cod, haddock, pollock), 60-65 kg/laborer/h.

The rate recorded for the deskinning operation (one laborer per machine) was 600 fish/h/machine/laborer. This rate is dependent, of course, on the type of machinery used. The direct use, without readjustment for ocean pout, of deskinning machines such as those used for flounder will enable processors to alternate from one species to another without complicating the daily flow rate.

Candling and Lesion Occurrence

Parasitic lesions were detected in 12 of the 204 fillets examined by candling. This represents a 6 percent occurrence in fillets. This value was comparatively lower than earlier reported values (Olsen and Merriman, 1946; Sheehy et al., 1974) which is probably attributed to differences in filleting, processing, and candling techniques as well as variation in fishing grounds and season.

While this study did not investigate the localization of lesions in a specific region of the fillets, Sheehy et al. (1974) reported that the incidence of lesions in the anterior ventral portion of the fillet was significantly higher than elsewhere. Similar observations were made by Olsen and Merriman (1946).

The infected areas, detected by candling, were cut out (with surrounding flesh) as narrow strips in such a way as to maintain the regular shape of the fillets. Consequently, the occurrence of lesions did not greatly affect the final yield. Similar candling and removal procedures are currently used in the processing of ocean perch and cod.

Yield

Laboratory processing of ocean pout with an average weight of 894 g/fish resulted in an average of 45 percent loss in the beheading and eviscerating steps. Filleting and deskinning (by hand) re-

Table 3.—Means of scores of organoleptic evaluation of deep-fried ocean pout and flounder fillets.

	Ocean pout	Flounder
Taste	8.2	7.9
Texture	8.8	7.2
Appearance	8.9	7.6
Odor	8.1	7.9

Hedonic scale of 9 points.
Number of panelists = 9.
Samples were battered and deep-fried in vegetable oil.

Table 4.—Means of scores of organoleptic evaluation of steam-cooked ocean pout and flounder fillets.

	Flounder (x)	Ocean pout (y)
Texture	+0.03	−0.03
Color	+0.55	+0.05
Odor	+0.09	0.00
Taste	+0.50	−0.11
Aftertaste	−0.30	−0.49

Samples were wrapped in aluminum foil, and steamed at 250°F for 17 minutes.
Number of panelists = 11.
Score (+4 to −4) with maximum acceptance at zero.
Statistical analysis: Taste, $xy^t_{(57)} = 1.72$; texture $xy^t_{(56)} = 0.89$. Therefore there is no significant difference ($t_{0.04\ (57)} = 2.39$)

Table 5.—Triangle test, difference analysis. Ocean pout versus flounder. R = right; X = wrong.

Panelists	First run	Second run
1	R	R
2	R	R
3	X	R
4	X	R
5	R	R
6	R	X
7	R	R
8	R	R
9	R	R
10	R	X
11	R	R
Total 11	9 R	9 R

First run: Two ocean pout samples and one flounder.
Second run: Two flounder samples and one ocean pout.
Consulting statistical charts (Larmond, 1970), for 22 panelists in triangle test, 18 correct judgments are significant at 5 percent level.

sulted in an additional 25-30 percent loss in weight. Thus the maximum yield in terms of carefully deskinned fillets was 30 percent of the original whole fish weight. Weight loss on removal of occasional lesions due to parasites was less than 1 percent.

A commercial filleting run was performed with 114.3 kg of fresh ocean pout, with an average weight of 1.09 kg/fish. The average yield in terms of deskinned fillets was 22 percent of the original whole fish weight. The yield could be increased up to 30 percent by starting the cut closer to the head; however, this resulted in an increase in labor time.

The yield of fillets varies with the fish species, but generally ranges from 20 to 40 percent of whole fish weight. Fish characterized by a large head and belly, such as ling cod and ocean pout, would be expected to fall in the lower part of the scale. For comparison, the yield of other species was 23 percent for cod, 30 percent for English sole, and 31 percent for flounder (Martin, 1976).

Table 6.—Chemical analysis of ocean pout fillets during the catch season. Values are averages of duplicate runs.

	Moisture (%)	Protein[1] (%)	Lipid (%)	Ash (%)
January (1975)	81.75	17.35	0.81	1.13
February	83.20	14.60	0.77	1.10
March	82.05	15.94	0.83	1.08
April	80.62	16.67	0.86	1.14
May	78.32	18.64	1.29	1.21
Average (variance)	81.19 (2.73)	16.64 (1.47)	0.91 (0.03)	1.13 (0.00)

Nonprotein nitrogen	314 mg NPN/100 g flesh
NPN/TN	11.76%
Cholesterol, fillets	52 mg/100 g fillets
Cholesterol, liver	197 mg/100 g liver (13.03% lipid)

[1]Protein = total nitrogen × 6.25.

Taste Panel Evaluations

The results of the first taste panel evaluation of ocean pout, prepared in the way common to the American consumer, i.e., battered, breaded, and deep fried (Run A), are presented in Table 3. Ocean pout fillets were rated over 8 points on a 9 point hedonic scale and were equally acceptable as flounder fillets in terms of taste, texture, appearance, and odor.

Table 4 contains the results of the second taste panel test which used steam-cooked fillets (Run B) to evaluate the unmasked characteristics of ocean pout. Results clearly demonstrate that ocean pout exhibits the desirable organoleptic parameters of taste, aftertaste, odor, texture, and color as their mean values were centered around zero and no objectionable remarks (extreme − or +) were reported by the panelists (standard deviation of 0.66). There was no significant difference in acceptability between ocean pout and flounder in the parameter tested.

Triangle test results (Table 5) indicate that the panelists generally could distinguish between ocean pout and flounder fillets. This demonstrates that the high acceptability of ocean pout was due to its own organoleptic characteristics rather than by its close resemblance to flounder.

Chemical Analysis

Analysis of ocean pout fillets for protein, lipids, ash, and moisture is presented in Table 6. Ocean pout is considered a very lean fish with an average of 1 percent lipid content. The average moisture, protein, and ash composition was 81.2 percent, 16.9 percent, 1.1 percent, respectively. It was also observed that there was no significant variation in the chemical composition of the fillets during the fishing season (January-May).

Table 7.—Fatty acid composition of lipids extracted from ocean pout fillets. Values are from a single run.

Fatty acid[1]	Percent
8:0	8.03
14:0	4.39
15:0	traces
16:0	24.86
16:1	11.53
17:1	3.72
18:0	7.95
18:1	34.92
18:2	4.58

Total saturated fatty acids = 45.24%
Total unsaturated fatty acids = 54.75%

[1]Number of carbon:number of double bonds

The amount of nonprotein nitrogen (NPN) was 314 mg NPN/100 g fillets, giving the NPN/TN (total nitrogen) ratio a value of 11.76 percent. This value is in agreement with that cited in the literature (Simidu, 1961) where teleosts such as ocean pout contained 9.2-18.3 percent NPN of the total nitrogen, while the elasmobranch possess higher values (33-57 percent). Nonprotein nitrogen contributes to fish odor, flavor, and acceptability, and is also considered a good substrate for bacterial attack. No attempts were made at this stage to identify the constituents of this nitrogenous fraction.

The fatty acid composition of ocean pout lipids extracted from the fillets is presented in Figure 9 and Table 7. It is noticeable that the saturated fatty acids constitute 42.24 percent of the total fatty acids and the unsaturated fatty acids sum up to 54.75 percent, i.e., roughly a 1:1 ratio. The results could have a significant application in the product development of ocean pout. While ocean pout is a very lean fish, 50

percent of these lipids are in unsaturated form, which makes the fish vulnerable to rapid rancidity if oxidation conditions are propagated during processing.

There have been a number of investigations concerning the composition of fish muscle lipids. In general the fat consists almost entirely of mixed triglycerides. The present analysis of ocean pout indicates that there was little or no fat accumulation and in this respect it is similar to cod or haddock. In these latter two white-fleshed species, most of the total lipids (less than 1 percent) occur as phospholipid and are mostly phosphatidylcholine and phosphatidylethanolamine.

Ocean pout are similar in fatty acid composition when compared to other lean fish such as ocean perch and rockfish in that the major fatty acids present in these species are 16:0 and 18:1 (no. of carbon:no. of double bonds) which together constitute about 60 percent of the total fatty acids (Gruger et al., 1964).

Ocean pout fillets show a low cholesterol concentration (53 mg cholesterol/100 g fillets). This value is similar to or slightly lower than some popular food fish species such as haddock and pollock which are 90 and 75 mg/100 g, respectively (Kritchevsky et al., 1967). Ocean pout has a considerably lower cholesterol content than shellfish such as oysters (150), shrimp (200), lobster (170), clams (190), and crabs (140 mg/100 g flesh) (Kritchevsky et al., 1967). Interest in cholesterol content in food has been stimulated by the concern for designing low cholesterol diets and ocean pout could provide a useful addition in these diets.

Summary and Conclusions

Ocean pout, an underutilized fish species, exists in New England waters and produces a lean, highly acceptable fillet.

The fish is potentially a good resource for the commercial fish market since it is abundant in the winter, it does not require special filleting machinery or major alterations in existing filleting lines used for other fish, and it gives a yield and labor rate which is commercially acceptable.

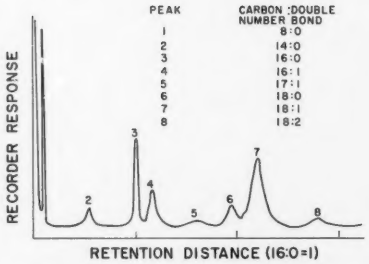


Figure 9.—Fatty acids of ocean pout lipids.

Work is now in progress covering the shelf life of fresh fish and the stability of frozen items. Studies are also underway for developing different product forms and investigating the heating and shrinkage patterns of the fish flesh and the proteolytic activity of the parasitic lesions.

MARKETING

Methods and Materials

The 2-year goal of the marketing project was to develop a viable demand for fresh ocean pout fillets within a limited geographical area. The development of a reasonable degree of sales volume was considered necessary in order to indicate the potential for success in an expanded marketing program covering a larger area.

The marketing program consisted of two phases. During the first year of the project the important areas of concern were the determination of the target market and assessment of product acceptability by the target market. The major emphasis during the second year was on expansion of test marketing through normal distribution channels and consideration of pricing and promotional plans. Throughout the project, a concerted effort was made to insure that the name "ocean pout" was used consistently, rather than any of a variety of local terms which could have detrimental connotations.

First Year Preliminary Evaluation

Initial results from the laboratory taste panel studies, which were conducted in the Food Science Department, gave strong indications of the high quality and potential consumer acceptability of ocean pout fillets. The target market was defined as those households in which fresh fish was consumed. The first year's testing concentrated on two critical aspects: 1) consumer reaction to an unidentified ocean fish (pout) served within the home, and 2) consumer and industry reaction to ocean pout merchandised in selected retail fresh fish markets.

Consumer reaction to fresh (unidentified) ocean pout fillets A random sample of 29 households was selected from the telephone directory serving the two adjacent towns of South Kingstown and Narragansett, R.I. A second random sample of 27 households was selected in a similar fashion from North Kingstown, R.I.

The homemakers, who were contacted by phone, agreed to cook and serve the test fish (ocean pout, not identified to the homemaker) in his or her customary fashion. The fresh fillets were delivered free to each household. A telephone interview was conducted the day after consumption to determine the response of household members. During the interview the homemaker was also asked, "What price per pound would you be willing to pay for the fish you prepared yesterday?" As points of reference, the following actual average prices per pound of fresh fish fillets were quoted: pollock, $1.19; cod, $1.69; and flounder, $1.99. The test fish remained unidentified to the homemaker until the close of the interview.

Test marketing of ocean pout in fresh fish retail markets A limited test marketing of fresh ocean pout fillets in five Rhode Island fish retail markets was conducted. Reputable markets which were willing to cooperate in this study were chosen by the Marine Advisory Service, URI. The five markets were geographically distributed throughout the State of Rhode Island and were located in Westerly, Point Judith, Newport, North Kingstown, and Johnston.

The test market period covered 5 weeks during which time four weekly deliveries of ocean pout were made, each being on a Thursday. Each delivery consisted of a 9 kg tub of fresh fillets that was given free of charge to the markets.

Ocean pout fillets were placed on sale at prices which were based on agreements between the market manager and the marketing project research coordinator. The coordinator's point of reference was $1.69/pound. This was based on prices which homemakers had indicated that they would be willing to pay, an assessment of the price necessary to assure a reasonable fair price to the fisherman, and the typical margins for all members of the normal chain of distribution. The final price decisions with the five markets ranged from $1.19 to $1.89, and reflected an attempt to provide some insight into consumer reaction to price.

A single sheet flyer which described the ocean pout project and contained general cooking instructions as well as two suggested recipes was prepared and distributed to all the markets. One of the recipes described a quick and easy batter fried fillet method and the other was for pout almandine. A note which solicited consumer reaction and recipe suggestions was also included.

Second Year Expanded Test Marketing and Profit-Loss Comparison of Cutting Methods

Expanded test marketing The second year marketing efforts were designed to cover a geographically larger market area and used normal commercial channels of distribution. Independent retail fish markets and supermarket chain headquarters were contacted and asked to merchandise ocean pout. Backed with the results from the pilot test of the first year, presentations were made to fish market owners and supermarket chain executives. This presentation included detailing the complete in-store merchandising program and in the case of supermarket chains, preparation of ocean pout recipes at market headquarters' kitchens. The in-store merchandising program included posters, free recipe booklets, and the assistance of URI students majoring in Home Economics to prepare samples of ocean pout and talk with consumers. Students offered bite-size samples to customers, described the ocean pout project, and answered any consumer questions.

Figure 10.—Cooking demonstrations were conducted to introduce consumer to ocean pout.

Most supermarket chains and independent fish markets featured ocean pout at $1.69/pound. In other instances ocean pout was sold at $1.79 and $1.99/pound.

A publicity and public reactions program was established as part of the promotional mix. Print and broadcast media were contacted and project personnel appeared on radio and television to describe the project. Cooking demonstrations and exhibits were arranged for various groups through the cooperation of the Rhode Island Home Economics Association (Fig. 10). Food editors of newspapers in the areas in which pout was being marketed were contacted and provided with nutritional information and recipe suggestions for ocean pout.

A new information and recipe leaflet was developed which included a brief story about the project and six suggested recipes which included, "New England Style Chowder," "Rice Stuffed Pout Fillets," "Fish and Chips," "Barbecued Pout," "Ocean Pout Poached in Wine," and "Ocean Pout Skillet Dinner." These recipes provided a variety of preparation methods from which to choose and went into a little more detail than the first year flyer. In addition a blue and white logo, created by a prominent advertising agency as a public service, was developed.

Profit-loss comparison of cutting methods Based on the results of the yield analysis conducted during the first year processing study an economic evaluation of cutting methods was conducted. The original yield investigation suggested that a significant increase in yield could be obtained by making the initial cut closer to the head than was normally done in commercial processing. Because this resulted in an increase in labor time, a cost-benefit analysis of the two cutting techniques was undertaken to determine which was the most profitable.

Two replicate filleting runs were made on 22 and 23 March 1976 for each cutting method in order to determine the variation in labor, time, and fillet yield. The first method was to make the initial cut from about 7.5 cm behind the head bone (near the anal opening). The second method was to make the initial cut directly behind the head bones. Each run was made with about 137 pounds of fish and used two cutters. The yield of fillets and labor time required for each method were recorded and the data used to develop a profit and loss statement comparison of the two methods.

Results and Discussion

First Year Preliminary Evaluation

Consumer reaction to fresh (unidentified) ocean pout fillets The major findings during the first year's study may be categorized as: 1) reaction to ocean pout as a menu item; and 2) reaction to retail prices. Table 8 summarizes the reaction by family units to fresh ocean pout as a menu item. Eighty percent of the households had a positive reaction to ocean pout. The results strongly suggest that many individuals find ocean pout fillets desirable as a menu item. It is interesting to note that the results for the North Kingstown and Narragansett-South Kingstown studies are almost identical.

Table 9 presents the results of the reactions of homemakers in terms of what they would be willing to pay for the fish that they tasted. Half of the responses to "What price per pound would you be willing to pay for the fish you prepared yesterday?" indicated they would pay $1.39 or more and 44 percent of this number said they would pay $1.69 or more.

It should be noted that 67 percent of the responses were directly related to the three prices which were included for reference points during the interview. Twenty-five percent said they would pay $1.19/pound (pollock), 27 percent said they would pay $1.69/pound (cod), and 15 percent said they would pay $1.99/pound (flounder).

A positive conclusion was warranted after analysis of the family reaction to pout as a menu item and of price data. The majority of families enjoyed ocean pout, commented favorably about it, and were willing to pay a moderate price for it.

Test marketing of ocean pout fillets in fresh fish retail markets The prices of ocean pout and other fresh fish in the five markets selected for retail studies during the first year are shown in Table 10. Pout was priced at $1.19, $1.69, and $1.89/pound. Since, with rare exception, all markets sold their total allotment (about 9 kg) each week it was not possible to determine any variation in consumer response either to price or by geographical area. Although 5 weeks is not a sufficient period of time to determine the total extent of repeat purchases and inquiries concerning the availability of ocean pout by consumers, market managers did report a number of repeat purchases and inquiries. Market managers also expressed enthusiasm about the recipe flyer made available to consumers and stated that they considered it a valuable merchandising item.

The results of the test marketing of fresh ocean pout fillets in retail markets was judged to be positive. The fact that ocean pout was consistently moved at several prices at all the markets was encouraging. The repeat purchases and inquiries which developed during the 5-week period suggested that expanded marketing efforts could be successful in developing a larger, sustained market for fresh ocean pout.

Table 8.—Reaction by family units to fresh ocean pout.

	North Kingstown		South Kingstown and Narragansett		Total	
Reaction	No.	%	No.	%	No.	%
Positive	22	81	23	79	45	80
Negative	5	19	6	21	11	20
Total	27	100	29	100	56	100

Second Year Expanded Test Marketing and Profit-Loss Comparison of Cutting Methods

Expanded test marketing Coordination throughout the distribution channel was achieved prior to the 1976 ocean pout season. A pricing strategy which reflected adequate margins for the fishing vessels, primary handler, cutting house, wholesaler, and retailer was established. The marketing coordinator carefully monitored the distribution channel on a weekly basis throughout the season and made suggestions to the trade, participated in advertising programs, and solicited additional retail establishments.

Industry cooperation during the second year expanded study was excellent. Four major food chains and about a dozen independent markets agreed to merchandise ocean pout. Rhode Island was the initial market area. Subsequently, Long Island, nearby southern Massachusetts, and Boston were included. Additional areas were covered as other industry members began to market ocean pout of their own accord.

The complete marketing plan proved to be highly successful. Whereas no significant amount of ocean pout was landed as edible fish in previous years at Point Judith, R.I., approximately 1 million pounds were landed for human consumption during 1976. This increase was a direct result of the demand generated through this project. During

Table 9.—Prices homemakers volunteered to pay for unidentified fish (ocean pout). (Number of times mentioned.)

Price per pound	North Kingstown homemakers	South Kingstown and Narragansett homemakers	Total	%	Cumulative % of total
$1.99 (flounder)	3	4	7	15	15
1.80	1	0	1	2	17
1.69 (cod)	7	6	13	27	44
1.59	1	0	1	2	46
1.50	1	0	1	2	48
1.39	0	1	1	2	50
1.35	2	0	2	4	54
1.29	0	1	1	2	56
1.19 (pollock)	8	4	12	25	81
1.09	0	1	1	2	83
1.05	0	1	1	2	85
1.00	1	1	2	4	89
0.90	1	1	2	4	93
0.79	0	3	3	6	99
Total	25	23	48		

Table 10.—Prices of ocean pout and other fresh fish fillets in selected fresh fish retail markets in Rhode Island communities.

Fish species	Johnston	Middletown	North Kingstown	South Kingstown and Narragansett	Westerly
Ocean pout	$1.19	$1.89	$1.69	$1.19	$1.69
Pollock	1.29		1.19		
Cusk			1.39		
Cod	1.89	1.79	2.09	1.59	1.89
Flounder	2.39	1.99	1.99	1.99	
Haddock	2.49		2.09		

the 4-week period between 15 March and 10 April 1976, ocean pout was the most abundant species landed in Point Judith. Ocean pout accounted for 25 percent of the total tonnage during this period and accounted for as much as 61 percent of some of the 2-day landing reports.

Profit and loss comparison of cutting methods The yield data indicate that the normal cutting method (7.5 cm behind the head bone) gave an average fillet yield of 23 percent. The second method in which the cut is made directly behind the head bone gave an average yield of 33 percent. These yields are similar to the results previously cited in the processing study for commercial and laboratory filet runs, respectively.

The results of the profit-loss comparison of the two cutting methods are presented in Table 11. These calculations were made by using the current information on the cost of whole fish to the processor ($1.17/pound), the cuttinghouse price of fillets ($1.05/pound), and the labor wage of $4.00/h for an order of 119 pounds of fillets (the amount of fillets which can be cut in 1 h under the standard method [a 23 percent yield]). The data demonstrate that while the new method (B, 33 percent yield) required an additional 34 minutes of labor time (costing $2.28), the increase in yield reduced the initial cost of goods required and resulted in a $24.58 increase in the profit margin. This clearly demonstrates the economic benefits which could be derived from the adoption of this cutting method. In addition the overall yield of fillets from a fixed amount of landed fish could thus be increased by 43 percent.

Table 11.—Profit and loss statement comparison for two fillet methods.

	Cutting method A (23% yield)	Cutting method B (33% yield)
Sales	124.95	124.95
Cost of goods sold	88.06	61.20
Gross margin	36.89	65.75
Expenses (labor)	4.00	6.28
Margin	32.89	57.47

Constants: $0.17—cost of round fish/pound.
$1.05—cuttinghouse price of fillets.
$4.00/h—hourly labor wage.

Summary and Conclusions

Consumer reaction to fresh ocean pout fillets has been positive. Results indicate that consumers consider ocean pout a desirable menu item and are willing to pay a moderate price for it.

A complete marketing program has proven successful in developing a market for ocean pout. While in previous years there had been no significant landings of ocean pout for human consumption at Point Judith, R.I., approximately a million pounds were landed in 1976.

It has been demonstrated that an increased profit can be realized by changing the traditional cutting method. When processing time is increased, the yield and profit margin are significantly improved. Adoption of this method is suggested.

The seafood industry in New England has been responsive to the marketing program and cooperation has been excellent. Although considerable success has been achieved during the expanded test marketing of ocean pout in a limited area, continuation of the marketing effort is strongly recommended to insure a final success involving all sectors of the industry in a self-sustaining effort.

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MFR PAPER 1253

Performance of Trawls Used in Resource Assessment

FRED WATHNE

INTRODUCTION

A major activity at the NMFS Northwest and Alaska Fisheries Center (NW&AFC) is determination of the status of fish stocks. The importance of this work is expected to increase markedly in waters off the United States with the advent of extended fisheries jurisdiction, since only with reliable data on the stocks is it possible to determine sustainable catch levels and to achieve successful management of the resources. At present, knowledge of the abundance of fish stocks is obtained primarily by analyzing commercial catch data and from research vessel surveys. For the latter, trawls are used to obtain samples of the bottom fauna which constitute the basis for estimating the quantity and species composition over an area much larger than that covered by the net. Extrapolation of the sample data is based on an assumption of certain dimensions and operating characteristics of the trawl gear and on an assumption as to the percentage of animals encountered by the gear that are actually captured. Because these two factors are critical to the calculations of stock sizes and consequently could carry important economic implications, it is necessary that every effort be made to ensure their accuracy.

To assist in obtaining a better understanding of how the sampling trawls perform under the wide range of operating conditions encountered, the NW & AFC began, in 1974, a project to develop suitable instrumentation for evaluating trawl performance during survey operations. The objectives of this operation are to determine the variability of trawl performance and assess the desirability of instrumentation as part of the sampling systems. It is not within its scope to attempt engineering studies of the gear or to establish reasons for variations in performance.

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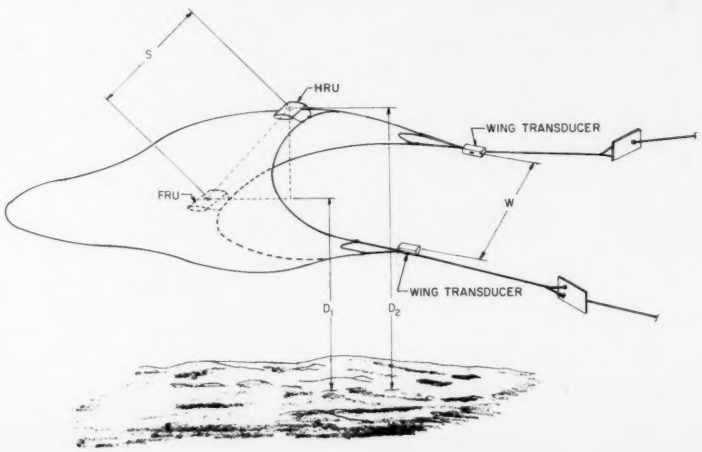
DESCRIPTION OF INSTRUMENTATION

For a number of years there has been interest in designing electroacoustic systems to measure the performance of trawls. Recent advances in electroacoustic and electronic technology make the design and construction of relatively simple, compact, and reliable instruments possible. Several experimental systems are available (French, 1968; Allison, 1971; Calon, 1971; Drever, 1971; Horn, 1971; Kodera, 1971; Lusz, 1971; Okonski and Martini, 1971; Savrasov, 1971; Smith and Stubbs, 1971; Steinberg, 1971) as are commercial instruments that measure a few parameters (e.g., depth to headrope or headrope-to-bottom distance). Complex and sophisticated units are also available (Carrothers, 1968) for conducting detailed engineering studies of trawl performance. However, because of their limitations with respect to measurement capability, data storage, and portability, as well as transmission problems and/or technical complexity, none of these systems were considered satisfactory for our purposes. Consequently, a contract was let to the Applied Physics Laboratory of the University of Washington, Seattle, for the design and construction of a suitable prototype system.

Consultations were held with the design engineers to outline the parameters needing measurement and the operational conditions expected. Compromises were reached to stay within available funds. The general goal was a system that would measure and record the desired parameters and would withstand the severe operating conditions encountered in trawling operations. It also needed to be relatively simple to operate and maintain. The resulting system (Acker and Brune, 1974) is shown schematically in Figure 1. It measures and records the headrope-to-bottom distance (D_2), the footrope-to-bottom distance (D_1), the wingspread, and the headrope-to-footrope distance (S). All information is stored in digital form on a small cassette recorder in the

Figure 1.—Schematic drawing showing relative locations of instrumentation system components.



headrope unit. A major concession to the cost limitation was forgoing a real-time surface readout.

The system consists of a headrope unit (HRU), a footrope unit (FRU), two wing transducers which are wired to the HRU, a cassette playback unit, and a battery charger. It measures and records the following parameters: 1) HRU to bottom, in feet (5-99); 2) HRU to FRU, in feet (0-99); 3) FRU to bottom, in tenths of a foot (0.9-15.0); and 4) wingspread, in feet (5-99).

Headrope Unit

The HRU contains a 120-kHz transmitter and receiver, a system timer and control, a signal processor, a transmit-receive steering network, and digital data storage. The timer determines the basic sampling period for the system. A switch on the timer can set a sampling interval of 3.3, 6.6, 13.2, or 26.4 seconds. Due to the ample battery life and data storage capacity, we utilize the shortest period almost exclusively. The sample period (T) is further divided into three subperiods: T_1, T_2, and T_3. During T_1, the HRU operates as an echosounder and records the distance to the nearest two objects, the first of which is usually the bottom. During T_2, a transponding system to the FRU is used. The FRU answers the HRU with two pulses; the first provides data on the FRU-HRU distance and the second on the distance of the FRU to the bottom. During T_3, the HRU measures the time required for an acoustic pulse to travel from one wing transducer to the other. HRU power is provided by a 4.5-ampere-hour, 12-volt gel cell battery that can operate about 60 hours at the fastest repetition rate before recharging is required.

The HRU electronic components are encased in a tubular housing designed for pressures to a depth of about 330 fathoms (615 m). External connections and an on-off-charge switch are mounted on one end-cap; the other end-cap is removable for access to the cassette recorder (Fig. 2). This unit and its faired housing (Fig. 3) weigh about 70 pounds in air but are neutral in seawater.

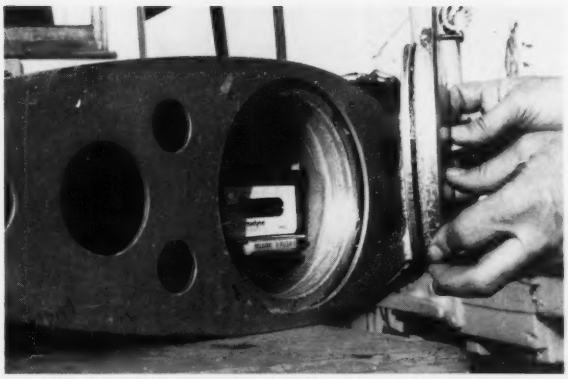


Figure 2.—Removing end-cap of HRU for access to the cassette tape.

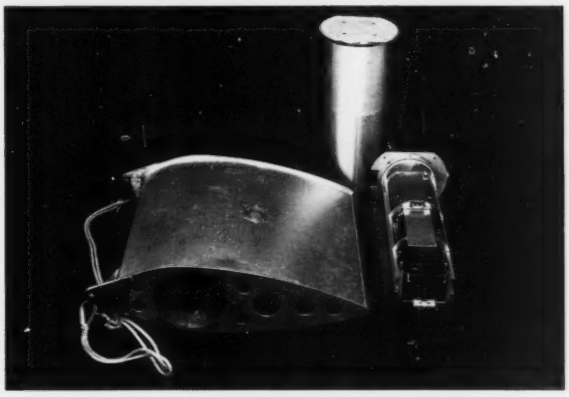


Figure 3.—The headrope unit components showing the electronic package, pressure vessel, and the faired housing.

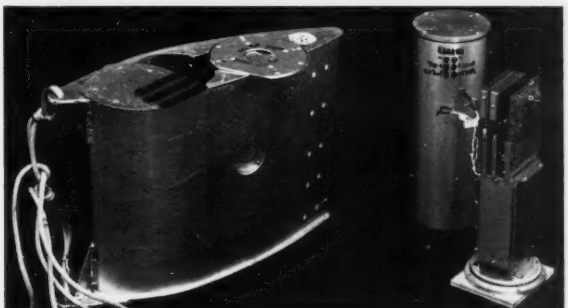


Figure 4.—The footrope unit components.

Footrope Unit

The FRU (Fig. 4) consists of a 120-kHz transponder, a 400-kHz echosounder, a timer, and a signal processing control. The transmitter and receiver design is essentially the same as that in the HRU. The 400-kHz circuit is used to measure the bottom distance and the 120 kHz for telemetry to and from the HRU. The timer and signal processor gather data and send them to the HRU for storage. FRU power is also provided by a 4.5-ampere-hour, 12-volt gel cell battery, and the electronic components are encased in a tubular housing. External connections are made

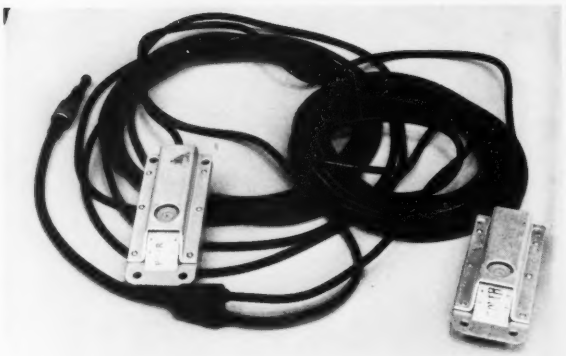


Figure 5.—Wing units used for measuring trawl spread.

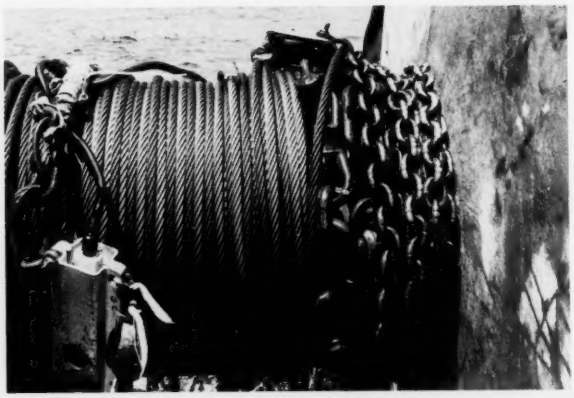


Figure 6.—Wing transducer wire crushed under dandyline while trawl is retreived on trawl drum.

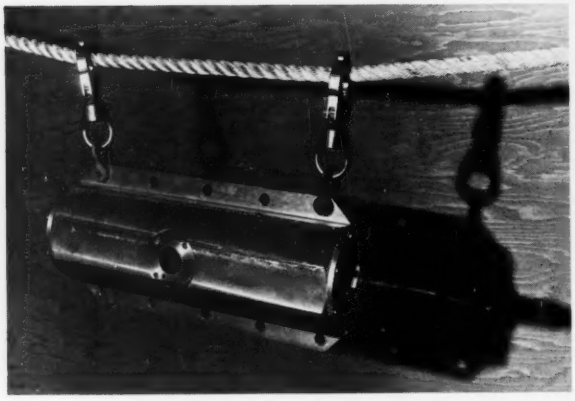


Figure 7.—Wing unit transponder.

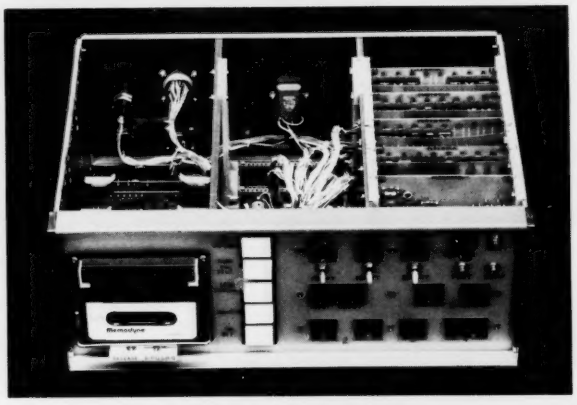


Figure 8.—Digital playback unit.

through the housing side wall with single-pin waterproof bulkhead connectors. An on-off-charge switch is located in one end-cap and both end-caps are removable. The housing is mounted inside a faired outer shell and the entire assembly is neutrally buoyant. Two transducers are housed in the fairing: a 120-kHz transducer with a beam width of 56° looks up and forward at an angle of 18°, and a 400-kHz transducer with a beam width of approximately 40° looks directly down. The assembly weighs about 35 pounds in the air but is neutrally buoyant in seawater.

Wing Units

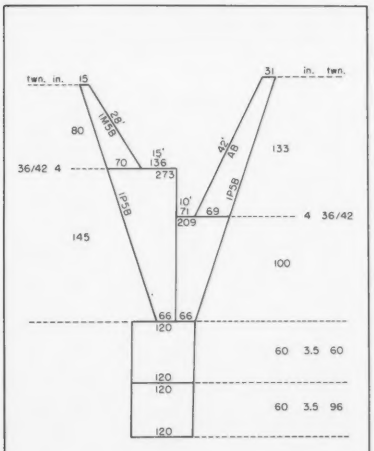
The wing units (Fig. 5) for measuring trawl spread initially consisted of two transducers each connected to the HRU by wire attached along the headrope. They had beam widths of about 60°. Problems with alignment between the two and wire damage due to handling during fishing (Fig. 6) resulted in system modifications, which have replaced one unit with a transponder and increased beam width of both to 150°. The first modification eliminated one headrope wire and the second reduced the alignment problem. The redesigned unit is shown in Figure 7.

Playback Unit

The playback unit (Fig. 8) consists of a cassette tape playback, controls, a clock, digital displays for each of the measured parameters, and the point-count number. The data can be displayed incrementally by sets of data, or a fast read can be used to skip portions of the tape. The playback unit also includes an interface to a digital computer for data processing.

Field Test Set

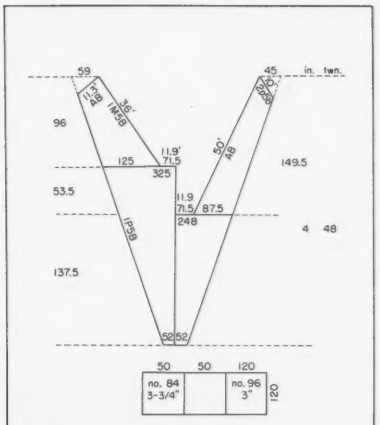
After a period of working with the system, we designed and constructed a portable field test set. Experience showed that use of such a system would reduce the number of "no-data" tows and the number of times the headrope unit needed to be opened to obtain the tape and verify system operation. Opening the HRU was usually done when we were exposed to the weather and, consequently, we not only risked getting seawater into the electronic components but increased the chance of O-ring damage. The test set determines if: 1) the headrope and wing transducers are working; 2) the coded pulse is arriving at the recorder; 3) the recorder motor is functional; 4) the wing and footrope systems are functioning; 5) the recorder head is engaged.



400-MESH EASTERN

Netting—nylon, preshrunk and dyed green.
Headrope—71 ft of ⅜ in, 6 × 19 galvanized wire rope wrapped with ⅜ in polypropylene rope.
Footrope—94 ft, ½ in, 6 × 19 galvanized wire rope srapped with $^{9}/_{16}$ in polypropylene rope.
Breastlines—6 ft, ¼ in proof coil galvanized chain.
Footrope wieght—¼ in, proof coil galvanized chain, 112.5 ft long (9 links per 7½ in hanging).
Flotation—15 pieces, 8 in diameter floats (5.5 lb buoyancy each).
Codend liner—1¼ in mesh, no. 18 nylon; 340 meshes around, 240 meshes deep, secured 15 meshes up from bottom of intermediate (leave about 2 ft of liner extending from end of bat).
Otterboards—5 × 7 ft V-doors, 820-850 lb each.
Dandylines—double, 20 fathoms, ½ in, 6 × 19 galvanized wire rope.

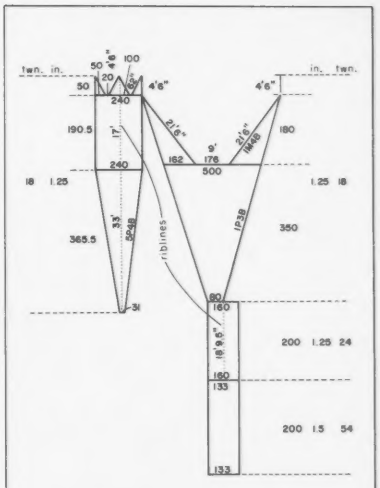
Figure 9.—Diagram of 400-mesh Eastern trawl used for resource assessment surveys at the NW & AFC.



83/112 EASTERN

Netting—nylon, preshrunk and dyed green.
Headrope—83 ft, ½ in 6 × 19 galvanized wire rope, wrapped with $^{5}/_{16}$ in polypropylene rope.
Footrope—111.8 ft, ⅝ in diameter, 6 × 19 galvanized wire rope wrapped with $^{5}/_{16}$ in polypropylene rope.
Footrope weight—$^{5}/_{16}$ in proof coil galvanized chain, 112 ft long.
Breastlines—½ in diameter galvanized 6 × 19 wire rope, wrapped with ¼ in polypropylene rope.
Riblines—¾ in diameter braided nylon extending length of first intermediate.
Flotation—40-8 in aluminum floats (5.5 lb buoyancy each).
Chafing gear—46 ML × 55 M around, 9½ in mesh, ⅜ in diameter polypropylene rope, hogringed.
Codend liner—1¼ in mesh, no. 18; 340 meshes around, 240 meshes deep.
Dandy lines—single 10 fathoms, ¾ in, 6 × 19 and 25 fathoms double (⅝ in top ¾ in bottom).

Figure 10.—Diagram of 83/112 Eastern trawl.



61' SHRIMP SAMPLING TRAWL

Netting—nylon, preshrunk.
Headrope—61 ft of ⅜ in 6 × 19 galvanized wire rope, tight wrapped with $^{5}/_{16}$ in polypropylene rope.
Footrope—61 ft of ½ in, 6 × 19 galvanized wire rope, tight wrapped with ½ in polypropylene rope.
Breastlines—20 ft of ½ in braided nylon (Stablebraid).
Sidepanel riblines—73 ft 3½ in of ⅝ in braided nylon (Stablebraid).
Flotation—29 pieces, 8 in diameter (5.5 lb buoyancy each).
Footrope chain—60 ft of ⅜ in suspended with six 12-in chain droppers (⅜ in diameter).
Tickler chain—55 ft of ⅜ in secured at wing tips.
Otterboards—5 × 7 ft V-doors, 815 lb.
Dandylines (sweeplines)—3 pieces, 10 fathoms each, top and middle of ⅜ in diameter, 6 × 19 galvanized wire rope, bottom of ½ in diameter; top with 24 in extension and middle with 18 in extension—both of ⅜ in proof coil chain.

Figure 11.—Diagram of 61-foot shrimp sampling trawl.

RESULTS

At the NW & AFC, three basic trawls are now used for resource assessment. The 400-mesh Eastern (Fig. 9) has been used for this purpose for about 20 years and is still used in the surveys which utilize vessels of less than about 500 horsepower. More recently, with larger survey vessels, an 83/112 Eastern (Fig. 10) has been adopted. The 4-inch mesh in both of these trawls is smaller than the 5- to 5½-inch used in the commercial fisheries of the area, but it is considered desirable to continue with the smaller size to ensure a degree of comparability of new data with those obtained in earlier years. The 61-foot shrimp sampling trawl shown in Figure 11 has been used during the last 4 years by both the National Marine Fisheries Service and the Alaska Department of Fish and Game for Alaska shrimp surveys.

400-Mesh Eastern Trawl Measurements

Data were obtained on this gear during 38 tows by the NOAA fishery research vessel *John N. Cobb* while engaged in Pacific hake, *Merluccius productus,* assessment cruises off California in the spring and fall of 1975. As shown in Table 1, the tows were made in depths from 30 to 145 fathoms using scope ratios (wire length:water depth) from 3.3:1 in the shallow end of the range to 2.5:1 on the deep tows. Choice of scope ratio was varied somewhat among cruises, especially during shallow tows.

The data from these two cruises indicate a number of performance features of interest. These include a large number of tows that were abnormal in some way with minor within-tow variability and greater between-tow variability. Of the 38 tows for which data were recorded, 11 (29 percent) were abnormal in that the trawl was off bottom for a substantial part of the time. On three of these, the trawl took from 7 to 11 minutes to reach bottom (standard tow length is 30 minutes) but functioned normally thereafter. On three others, the gear fished normally during the first part of the tow but left bottom after 10, 14, and 18 minutes, respectively, and remained off bottom during the rest of the tow (Fig. 12). On tows 56 and 69, the gear was off bottom 1-2 feet or more intermittently throughout the tow. The remaining three abnormal tows involved late arrival on bottom (15 minutes), intermittent bottom contact, and fluctuating wingspread measurements ranging from 10 to 50 feet. The widely varying wingspread indicates the gear was not

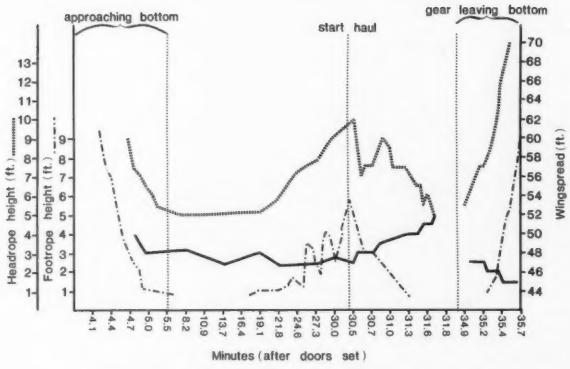


Figure 12.—Graph of data showing gear leaving bottom about 12 minutes before hauling started.

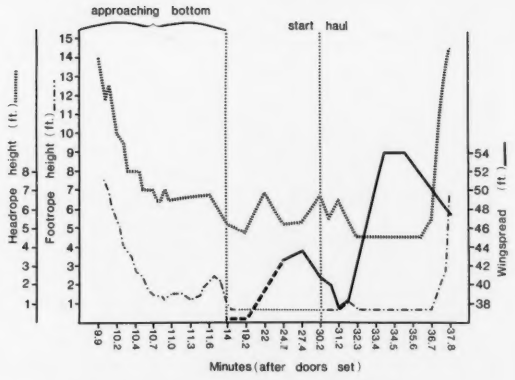


Figure 13.—Graph of data from tow 62—C75-2.

spreading properly. Figure 13 illustrates the performance of the net on tow 62, which was typical of these three tows. The delay in reaching bottom, narrow and widely fluctuating wingspread measurements, and the loss of both wing and FRU data suggest severe distortion of the trawl probably due to water currents acting on the vessel and gear.

On tows where problems with performance were not detected, within-tow variability was very low. The vertical opening fluctuated less than ±0.25 foot and the horizontal spread less than ±1.5 feet. Figure 14 is a plot of these data for a typical normal tow. However, between-tow variation of horizontal spread was somewhat greater, with a range from about 36 to about 48 feet. A plot of wingspread against depth of tow (Fig. 15) suggests that, within these depths, spread increases with depth; the greatest rate of change is at the shallow end of the range. The vertical opening on the tows deeper than 40 fathoms was 5 feet or less in all tests. On the 10-fathom tows, it ranged from less than 5 feet to 7 feet.

Eastern Trawl (83-112 Foot) Measurements

With the trend toward larger research vessels in recent years, it was necessary to select a sampling system to better match their greater power. The trawl shown in Figure 10 was chosen as a compromise which would do this and retain the principal sampling characteristics of the 400-mesh Eastern trawl. The gear was studied in the fall of 1975, on a resource assessment cruise with the NOAA fishery research vessel *Miller Freeman*—a 2,000 horsepower stern trawler. The otterboards were 7 × 10 feet, V-design, and weighed 3,000 pounds each. The trawling warp was 1 inch in diameter. Unfortunately, the wingspread measurement circuit was not functioning on this cruise and, therefore, only HRU and FRU data were obtained. Consequently, observations of performance were limited to

Table 1.—Trawl parameters observed during cruises of the *John N. Cobb* during spring and fall of 1976.

Season and tow no.	Depth (fathoms)	Scope ratio	Time to bottom (minutes)	Spread (feet)	Height (feet)	Bottom contact	Problem tow
Spring							
58	30	3.3	2.2	—	4.5	good	—
67	36	3.3	3.1	44	4.5	good	—
65	40	3.0	5.5	44	4.5	good	—
48	50	3.0	15.0	—	—	—	x
49	50	3.0	2.4	43	4.6	good	—
53	50	3.0	3.9	44	4.8	good	—
59	54	3.0	3.2	46	4.5	good	—
40	54	3.0	2.0	46	5.2	poor	x
51	70	3.0	1.9	47	4.5	good	—
64	70	3.0	11.0	44	5.0	good	x
39	77	3.3	4.8	46	5.0	good	—
60	88	3.0	4.3	—	5.0	poor	x
46	106	2.8	3.4	49	5.0	good	—
56	106	3.3	4.3	51	5.0	erratic	x
62	132	2.7	14.6	—	5.8	—	x
52	145	2.5	7.6	47	5.0	—	x
Fall							
76	43	3.5	3.0	—	5.5	good	—
80	45	3.6	—	—	5.5	good	—
84	45	3.6	2.0	—	5.5	good	—
68	51	2.9	3.0	—	5.5	—	—
90	54	3.2	3.0	—	5.5	—	—
71	58	2.8	4.3	44	5.5	—	—
77	62	3.1	4.7	—	5.5	good	—
83	63	3.0	4.7	—	5.5	good	—
75	70	3.0	5.2	—	6.9	poor	x
85	75	3.0	3.8	—	5.5	good	—
69	75	3.0	4.5	45	5.5	poor	x
78	75	3.0	4.9	—	6.0	good	—
79	75	3.0	4.5	—	6.0	good	—
81	77	3.0	4.1	—	5.5	—	—
72	83	3.0	5.1	47	6	poor	x
74	92	3.0	4.4	—	5.5	—	—
70	94	3.2	3.7	—	5.5	—	—
73	106	3.0	5.6	—	5.5	—	—
82	108	2.9	5.4	—	5.5	good	—
91	110	2.7	3.4	—	5.5	—	—
86	110	3.0	4.6	—	5.5	—	—
87	111	2.7	7.1	—	5.5	—	x

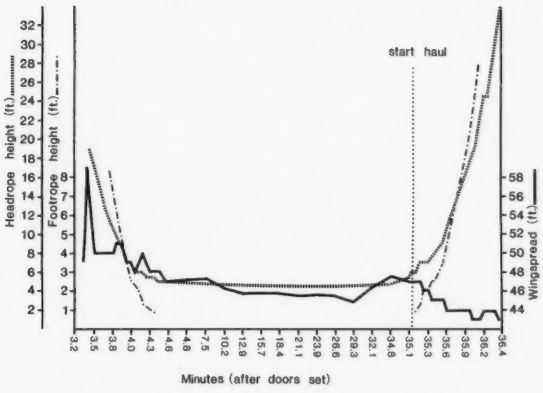


Figure 14.—Graph of data from tow 39—C75-2.

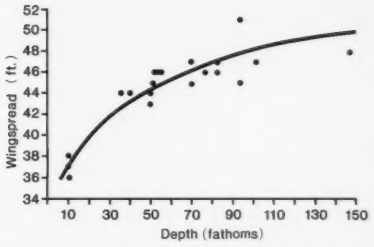


Figure 15.—Wingspread-towing depth relationships for the 400-mesh Eastern trawl. Curve fitted by inspection.

measurements of time to reach bottom, vertical opening, and footrope bottom contact. This gear settled to the bottom much faster than the 400-mesh Eastern. The average time was only 2.2 minutes and ranged from about 0.5 to 6.0 minutes, except for tow 85 in 194 fathoms, when it took 13 minutes. This was the deepest tow of those observed with the instruments during the cruise.

The gear was off bottom while towing on only six of the 77 tows for which data were recorded and only for a maximum of 1.2 feet. Again an exception was tow 85, when the trawl was off bottom from 1.5 to 5.0 feet for 75 percent of the time after it had reached bottom. On this 30-minute tow, the gear was on bottom only about 4 minutes, or 13 percent of the towing time.

The effect of floats on the headrope height was found to be significant. With 40 floats (288 pounds buoyancy), the average height measured on 28 tows was 7.6 feet (range from 6.3 to 9 feet). In nine tows with 30 floats (216 pounds buoyancy) the average height was less than 5.5 feet (range from less than 5 to 6 feet). Data from the FRU showed that the greater headrope height was the result of a change in trawl shape rather than of lifting of the gear off the bottom.

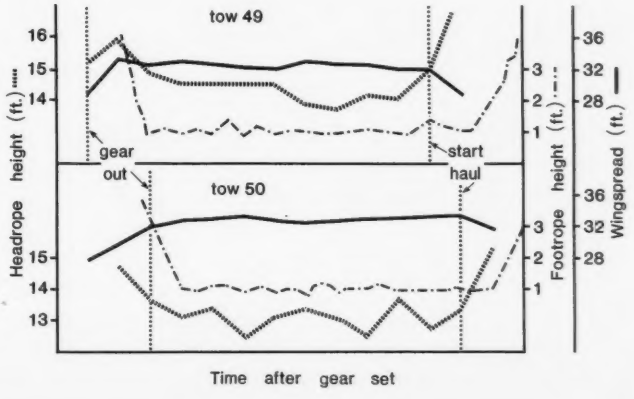
Another variation noted was a difference in vertical opening between two presumably identically rigged nets of the same design and from the same manufacturer. Net no. 1 was used on tows 7-9 with an average vertical opening of 7.8 feet. Net no. 2 was fished on tows 10-13 with an average opening of 6 feet. In another series, net no. 1 was measured 16 times between tows 20 and 40 and had an average opening of 7.2 feet. On the 13 observations of net no. 2 on tows between no. 41 and no. 60, the average was 5.5 feet. The reason for the substantial difference in this parameter between the two trawls is unknown.

61-Foot Shrimp Sampling Trawl Measurements

The shrimp sampling trawl (Fig. 11) was designed by NMFS personnel specifically for assessment of the shrimp stocks in the waters near Kodiak, Alaska. The major objective of the design was a trawl with a larger vertical sampling capability than the Gulf of Mexico shrimp trawl designs used in earlier surveys. The net is fished from 5 × 7 foot V-doors on 10-fathom triple dandylines (the wire assembly between the trawl and doors).

Data were obtained on 10 tows in May 1974, during a shrimp assessment cruise of the NOAA fishery research vessel *Oregon* in Alaska. Although measurements were incomplete due to equipment and operational problems, they provided some indication of the gear's performance. Time to bottom on the three tows where it was obtained averaged 3.7 minutes, which is within the normal range measured on the Eastern trawls for tows in similar depths (approximately 90 fathoms). On tows 49 and 50, complete data were obtained (Fig. 16). It appears that when operating normally in 90 fathoms, this gear fishes about 1 foot off bottom, spreads about 32-34 feet, and opens vertically 11.5-13.5 feet (headrope height minus footrope distance off bottom). Both distance off bottom and the horizontal spread were relatively stable but the

Figure 16.—Graph of data from tows 49 and 50, *Oregon* cruise 75-1.



vertical opening fluctuated considerably more than was found for the Eastern trawls. The percentage change of the footrope height off bottom was large (30 percent) but the absolute change was only 3.6 inches. On tow 58, the horizontal spread was a relatively steady 37-38 feet, suggesting that between-tow variability may be of some significance with this gear also. Data on the other two parameters were not obtained on this tow. The remaining tows produced limited data which were variable and usually outside the ranges described above. For example, on tow 51 the headrope height ranged from 16.5 to 18.5 feet, which is much greater than on tows 49 and 50 (as was the variability). FRU data were not obtained, so how much of this is attributable to the trawl being off bottom is not known. Other tows produced similar erratic data and frequent loss of signals, suggesting that distortion of the gear due to water currents was probably a factor.

In a separate experiment with this trawl, the effect of load-bearing riblines on net configuration was tested. The four riblines are installed with the webbing hung in 13 percent (ribline length is 13 percent less than the stretched mesh length of the webbing hung to it). Commercial shrimp trawls usually have no riblines or they are as long as or longer than the stretched mesh webbing to which they are attached. The first series of tows was made with the riblines and the second with them removed. As depicted in Figure 17, there was a marked decrease in vertical opening without the riblines, especially at the higher speeds. The effect on horizontal spread was minor. Likewise, towing speed and total warp tension were not noticeably affected by the presence or absence of the riblines.

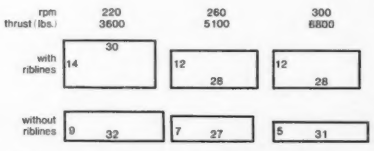


Figure 17.—Changes in dimensions of the 61-foot shrimp sampling trawl with and without riblines at three towing speeds.

It is of interest to note that commercial shrimp trawlers in the northeastern Pacific Ocean obtain larger catches at towing speeds of only 1-2 knots than at the usual speeds of about 3 knots. Possibly one reason for reduced catches at higher speeds is the reduced vertical opening of the trawl.

Other Observations

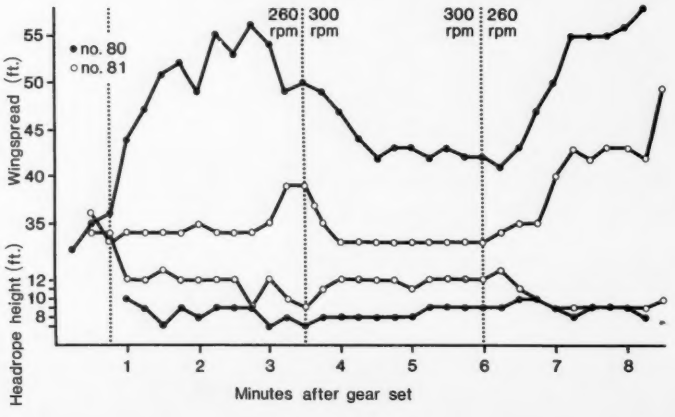
During early trials with the instruments in Saratoga Passage, Puget Sound, a series of tows with a modified Eastern trawl in 45 fathoms revealed an interesting phenomenon apparently related to the tidal currents in the area. The trawl used was similar to the Eastern trawl reported earlier and shown in Figure 9. The otterboards were the same. A major difference was that 40, rather than 20-fathom dandylines were used.

The experimental procedure was to tow at an engine speed of 260 rpm for 3.5 minutes, increase to 300 rpm for 2.5 minutes, and reduce again to 260 rpm for 2 minutes. In seven paired tows (one north and one south), the measurements were relatively stable at both speeds in one direction although the spread was narrower and the height greater than would be expected at this depth. The behavior in the opposite direction, however, was extremely erratic. At the low speed, the spreads were very wide (to 55 feet) and variable. The vertical opening was higher than normal but comparatively stable at both speeds. A graph of the measurements from one pair of tows is shown in Figure 18.

Of interest also, was the HRU to FRU measurement during the erratic tows. At the low speed, this measurement decreased from the normal 18-19 feet down to 9 or 10 feet, increased back to normal when the speed was increased, and decreased again when speed was reduced. This also suggests severe distortion since the two units were apparently almost one above the other at the slow speeds. The apparent distortion is probably related to tidal currents—on some days it occurred when towing to the north but on others to the south.

A limited number of observations were made of an 82-foot shrimp trawl used for groundfish assessment surveys in the Gulf of Mexico. This gear is fished on 12 foot by 5 foot otterboards with only 9 foot dandylines (leglines). Two tows in 40 fathoms in the same location but in opposite directions showed the gear reaching bottom at 7 and 4 minutes. This is of some interest since the standard towing time in these surveys is only 10 minutes. The gear spread about 56-57 feet and opened vertically 7 to 8 feet. Figure 19 is a graph of the vertical and horizontal measurements taken on tow 31. Although the headrope measurements in particular were more erratic than with other gear

Figure 18.—Graph of data from tows in Puget Sound's Saratoga Passage showing erratic trawl configuration at slow speed in one towing direction.



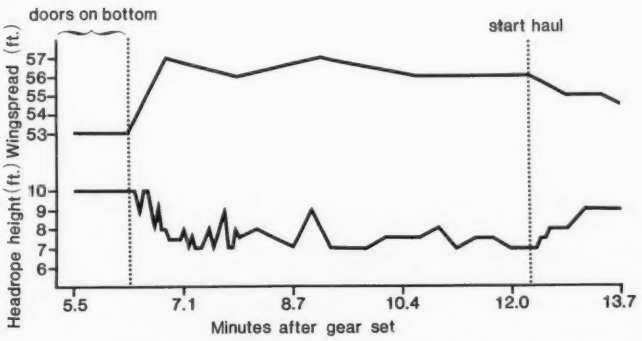


Figure 19.—Graph of data from tow with an 82-foot shrimp trawl.

measured, it appears the trawl reached bottom when the spread increased from 53 to 57 feet and vertical opening dropped from 10 to about 7 feet. This change in geometry is what is expected when the otterboards move from midwater to the bottom where a greater spreading force is developed and is especially true when very short dandylines are used.

On the two tows in 100 fathoms, the data obtained suggest the gear did not reach bottom at any time during either tow. Failure to get readings from the FRU precludes a positive determination of this, but the minimum of 10 feet on the HRU measurement and the 52-53 foot wing spread throughout the tow indicate the otterboards were not in contact with the bottom and therefore not spreading the trawl fully. The absence of any catch in either tow tends to confirm this.

SUMMARY

Measurements to date indicate that the performance of assessment trawls used at the NW & AFC is more variable than had been assumed. In particular, the bottom contact in the forms of late arrival on bottom, lifting off bottom early, or sporadic contact throughout a tow was found to be of some significance at times—especially on deeper tows and in areas of strong currents. Variability of trawl spread and headrope height was found to be relatively small within the 30-minute tows but somewhat greater between tows. These variations are probably the result of water currents acting on the gear and vessel.

The instrumentation is currently being modified to eliminate the wire used for transmitting the wing spread data to the HRU; a trawl-to-vessel acoustic telemetry link is being incorporated to provide a real-time readout at the surface. The recording of data at the HRU will continue, however, at least until experience demonstrates that data loss due to transmission problems is at an acceptable level.

The equipment will continue to be used for acquiring data on resource assessment trawls during survey operations to better understand what variation in performance occurs under the various conditions the gear is used. A primary objective will be to determine the potential value of incorporating certain instrumentation as an integral part of the sampling systems.

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U.S. Commercial Fish Catch and Value Jump in 1976

United States commercial fishermen had a successful year in 1976, landing more fish than in any year since 1962 and more edible fish than in any year since 1952, Robert W. Schoning, Director, National Marine Fisheries Service, has announced.

The near-record total landings came to 5.4 billion pounds of fish, for a total value of $1.4 billion, he said. This was up 39 percent from the value of commercial fish landed in 1975, $971 million. The quantity landed was 11 percent more than in 1975 and only 4 million pounds less than the 1962 record.

Record landings of two important shrimp, 404 million pounds—and improved landings of crabs, 345 million pounds; salmon, 309 million pounds; flounders, 165 million pounds; and cod and other groundfish, 157 million pounds, accounted for a large share of the increase.

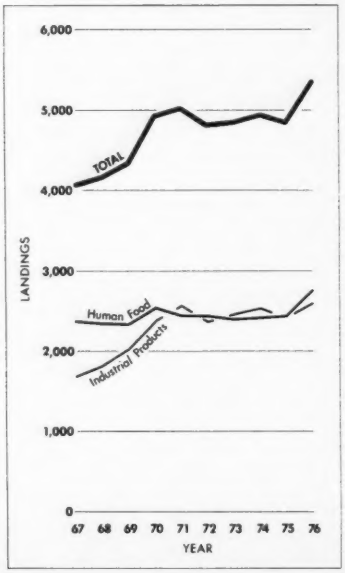
"Commercial landings in the United States of edible species," Schoning said, "were 2.8 billion pounds, valued at $1.3 million, up 14 percent in quantity and 40 percent in value." The quantity landed was considerably above the average for the previous 5 years.

Landings at U.S. ports of species used for reduction to fish meal and for other industrial purposes were 2.6 billion pounds valued at $89 million in 1976. This quantity, 7 percent greater than in 1975 and 5 percent above the average for the previous 5 years, was short of the record amount landed in 1962. The increase in quantity was due to heavy landings of menhaden.

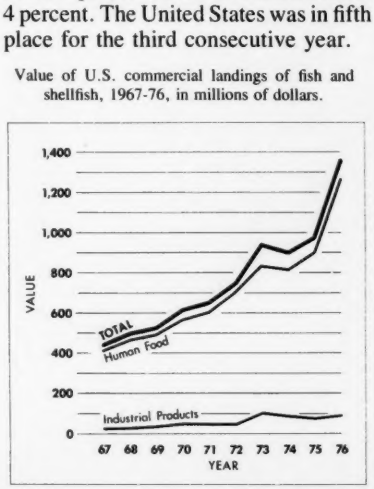
The total value of domestic production of processed fishery products (edible and industrial) was $3.2 billion in 1976, up 22 percent over 1975. The value of edible products, which comprise almost 90 percent of the total, was nearly $2.9 billion, up 23 percent in 1976. The value of industrial products in 1976 was $377 million, up 16 percent over 1975.

World landings in 1975 were 69.7 million metric tons (153.7 billion pounds) down 1 percent from the 1974 production of 70.5 million metric tons (155.4 billion pounds). Japan, with 15 percent of the total landings, continues to be the world leader in fishery landings, followed by the U.S.S.R. with 14 percent, the Peoples Republic of China was third with 10 percent, followed by Peru, 5 percent, and the United States, 4 percent. The United States was in fifth place for the third consecutive year.

United States commercial landings of fish and shellfish, 1967-76, in millions of pounds.



Value of U.S. commercial landings of fish and shellfish, 1967-76, in millions of dollars.



Catch and value of several important marine species, 1975-76, by U.S. commercial fishermen.

	Thousand pounds		Thousand dollars	
Species	1975	1976	1975	1976
Tuna	391,149	485,506	108,377	149,765
Shrimp	343,586	403,577	226,240	331,375
Crabs	300,950	344,810	84,135	136,955
Salmon	201,591	309,242	116,298	196,496
Flounders	156,324	164,682	43,233	52,007

Source: Fisheries of the United States, 1976.

During 1976, U.S. ex-vessel prices (prices received by fishermen for their landings) moved upward in most months and were at, or near, record levels by the end of the year. The largest gains were for shellfish. The same upward movement was apparent in prices quoted at the wholesale level for fresh, frozen, and canned fishery products.

Per capita consumption for the United States in 1976 reached 12.9 pounds of edible meat per person, tying the record set in 1973. This was 0.7 pound more than the 12.2 pounds eaten in 1975.

New Weather Services Designed for Mariners

New types of environmental services tailored to the needs of mariners are being developed by National Oceanic and Atmospheric Administration (NOAA) meteorologist-oceanographers in Seattle. The experimental effort by the Commerce Department agency's National Weather Service combines computer predictions of winds, waves, ocean swell, and weather with "handmade" analyses of satellite data, Arctic ice-cover data, ship observations, and other weather information.

Its products include forecasts for tug and barge traffic based in Puget Sound and en route to Alaska, ice advisories for the Bering and Chukchi seas, and special forecasts for NOAA research vessels and for people caught in

weather-connected emergencies at sea. Developed by the Seattle Ocean Services Unit of the Weather Service Forecast Office, these products give the mariner a degree of specialized weather information similar to that given aviators for cross-country flights. The difference is that ocean forecasters have a limited picture of actual weather conditions at sea, and so have less information upon which to base a prediction.

The Seattle unit is led by Robert Anderson, formerly with the Naval Oceanographic Office in Maryland, and ocean forecaster Bill Burton. NOAA Lieutenant Commander Kenneth Lilly, and Captain Graham Britton, Royal Navy (ret.), a noted British meteorologist associated with the Sea Use Council, pioneered the present set of experimental services. (The Sea Use Council is a private, regional organization concerned with the long-term scientific and economic development of the northeastern Pacific area.) Two additional forecasters are joining the unit this year.

"We've been developing a family of special services for NOAA vessels," Lilly said, "to give them a better meteorological context for their operations, especially in Alaskan waters, where weather changes quickly. At present, the forecasts provided extend to only 24 hours. Last fall, we began providing 24- and 48-hour forecasts, and outlooks that extend to 3-7 days, depending on how fast the weather systems are moving. We also issue summaries of Navy ice charts and bulletins and NOAA ice information tailored to the particular needs of our ships."

Because their products are experimental, the Seattle forecasters are free to try innovative approaches and formats, unconstrained by the usual stringent requirements of Weather Service Forecast Offices. Thus far, the Ocean Services Unit has been trying to evaluate how well the services fit the needs of particular users, and whether the products should be considered as possible additions to the regular run of Weather Service data.

"There's quite a variety," according to Lilly who this spring returned to sea duty on the NOAA Ship *Discoverer*. "We've been responding to tug and barge companies, giving their dispatchers weather data and general outlooks. This can be valuable to them, in the sense it helps them decide whether to keep to the coastal passages along southeastern Alaska, or to cut across the Gulf, which saves time and money."

When the occasion arises, Lilly noted, the experimental service is used to help someone in trouble. "We had one sailboater coming up from Hawaii who radioed that he had a broken spreader bar, which means he couldn't tack into the wind. His wife would call daily and we'd tell her how he could avoid tradewinds and strong westerlies, where fog was predicted, and the outlook for waves and swell."

Alyeska Pipeline called last spring, Lilly said, wanting a forecast out to 6 or 7 days because they were shipping a critical cargo to Alaska. "We could give them a 5-day forecast, and the forecast turned out to be an accurate one." Other special forecasts have been made for area sailboaters, for NOAA's data-buoy developers, and for the Bicentennial sailing vessel *Explorer* on the Pacific coastal leg of her voyage to New York.

According to Lilly, the trend in Ocean Services Unit is toward developing improved marine weather forecasts for the general boating public. "We're looking now at whether the marine weather forecasts can be made more detailed, and perhaps upgraded with some special forecasts of the type we're doing now."

The ocean weathermen, with research assistance from NOAA's Pacific Marine Environmental Laboratory, also are bringing more "wet" data into their meteorological work, to develop new products for people who use the sea. For example, they expect to develop regional sea-surface temperature maps, based on data from ships and the infrared sensors aboard NOAA satellites. These maps will show where the boundaries are between thermal regimes in the sea—boundaries that generally mean good fishing. They also are refining their forecasts of conditions over the Columbia River bar, where combinations of bar structure and wind fields can produce extremely hazardous conditions.

Another aspect of the work is to get out and talk to the people who use marine weather information, to see what that public—a very large public in the Northwest—feels it needs. A handbook on hazardous weather for small boat operators in Washington is in the works, as part of a related public education effort.

The experimental ocean weather information takes several forms. One is a surface weather chart similar to those prepared for the continent, but analyzed in extensive detail for the coastal waters of the Northwest.

Weather advisories for NOAA ships and tug and barge traffic between Seattle and the Bering Strait use a map with 14 letter-designated locations—location W, for example, is about 90 miles (144 kilometers) northwest of

NMFS WILL INSPECT ARMED FORCES FISH

The inspection of certain fish products for the Armed Forces has been transferred from the Department of Defense to the Department of Commerce. Inspectors from the Commerce Department's National Marine Fisheries Service (NMFS)—the agency charged with setting quality standards and inspecting and certifying fishery products—will assume the responsibility from the Defense Logistics Agency.

The NMFS currently inspects over 800 million pounds of fisheries products annually under its voluntary, fee-for-service program. "Under our contract inspection service, special attention is given to plant sanitation, product safety and wholesomeness, quality, species identification, and proper labeling for either fresh or processed fish products," Thomas J. Billy, Chief of NMFS' Seafood Quality and Inspection Division, said.

Cape Flattery. These messages include outlooks for gales and predicted waveheights at those locations for the ensuing 24 and 48 hours, and third-day outlooks for the Gulf of Alaska and Bering Sea. They bring together in one package forecasts which have originated in Weather Service Forecast offices in Anchorage and Seattle.

Tuna-Porpoise Rules Listed For 1977

Regulations that will further reduce the number of porpoises killed by U.S. tuna fishermen have been published by the National Marine Fisheries Service, an agency of the Commerce Department's National Oceanic and Atmospheric Administration. A quota of 59,050 porpoises has been established for 1977, a 24 percent reduction from the 1976 quota of 78,000. Except for a short period of time, fishermen have been prohibited from encircling porpoise with their nets since November 1976, pending issuance of the new regulations.

Following issuance of the regulations, fishermen can apply to NMFS for permits to take marine mammals incidental to their fishing operations. Prior to issuance of a permit, the National Marine Fisheries Service must forward the evidence developed from the application and its recommended disposition of the permit application to the District of Columbia Circuit Court of Appeals for its approval. Normally, the American Tunaboat Association applies for a general permit and individual fishermen later apply for certificates of inclusion to operate under the general permit. The association's general permit was issued in April (see following article).

The regulations and quota apply to U.S. fishermen conducting yellowfin tuna purse seine fishing operations. They forbid setting nets around mixed schools containing eastern spinner (which is considered depleted), coastal spotted, and Costa Rican spinner dolphins (for which no population estimates are available). Sets are also prohibited on "pure" schools (schools of one species only) except offshore spotted and common porpoise.

Porpoises frequently are found in association with schools of yellowfin tuna and thus are used by fishermen to locate the tuna. In the course of fishing operations porpoises may become entangled in the fishing nets and suffocate.

Detailed quotas established by the regulations are as follows: 1) 43,090 offshore spotted dolphin; 2) 7,840 whitebelly spinner dolphin; and 3) 8,120 of 10 other incidental species of dolphin.

The quotas are based on the recommendation of an Administrative Law Judge, who heard information presented during hearings last fall, and on the requirements of the Marine Mammal Protection Act of 1972 which directs that incidental mortality be reduced to an insignificant level approaching a zero rate.

All fishermen who operate under the permit to take marine mammals must also agree to take an NMFS observer aboard their vessels, upon request, to conduct research and observe operations. It was expected that observers would be placed on approximately 40 percent of all tuna vessel trips after mid-April, if supplemental appropriations were approved.

Other provisions of the regulations provide that marine mammals taken incidentally to fishing be immediately returned to the ocean; that fishermen take steps to minimize incidental kill and serious injury to marine mammals; that they maintain daily logs on all sets in which marine mammals are taken; and that certain types of gear and fishing procedures be used, including a large area of small-mesh porpoise safety panel. The regulations also forbid importation of any fish that were caught in a manner which is prohibited by the regulations.

Permit Issued to U.S. Tunaboat Group for 1977

The Commerce Department's National Oceanic and Atmospheric Administration announced on 15 April that a general permit, for the taking of marine mammals incidental to yellowfin tuna purse seine fishing operations, had been issued to the American Tunaboat Association, San Diego, Calif., on behalf of all U.S. yellowfin tuna fishermen.

The general permit was issued by NOAA's National Marine Fisheries Service under previously established regulations relating to encircling gear used during yellowfin tuna purse seining operations in the eastern tropical Pacific. It is valid until 31 December 1977, unless amended, suspended, or revoked by the Director of the National Marine Fisheries Service (NMFS). Under the permit, no more than 59,050 porpoises may be killed in 1977, a 24 percent reduction from the 1976 quota of 78,000.

After 14 March, yellowfin tuna fishermen had been allowed to fish on porpoise under a court order which permitted them to kill up to 9,972 porpoises until a new permit was issued. However, they were prohibited from taking any whitebelly and eastern spinner porpoise. Under the 1977 permit, they will be permitted to kill up to 7,800 whitebelly, but the prohibition on eastern spinner remains. Those already taken this year will be counted as part of the total allowable kill for 1977.

Regulations and the permit forbid U.S. fishermen conducting yellowfin tuna purse seine fishing operations from setting nets around mixed schools containing eastern spinner (considered depleted), coastal spotted, and Costa Rican spinner dolphins. Sets are also prohibited on "pure" schools (schools of one species only) except offshore spotted and common porpoise.

The general permit was issued in compliance with regulations issued on 1 March (see previous article), under the Marine Mammal Protection Act of 1972. The Act was passed to protect, maintain, and if necessary, rebuild the populations of marine mammals and, among other things, restricts the taking and importing of marine mammals and marine mammal products.

As there are times when fishermen

might unavoidably take marine mammals during their normal fishing operations, the Act and regulations provide for the issuance of general permits and certificates of inclusion that allow fishermen to take marine mammals incidental to their commercial fishing operations.

Other conditions of the general permit and the certificates of inclusion under the permit require, among other things, that U.S. commercial fishermen take special measures and use special fishing gear to avoid seriously injuring or killing marine mammals in their fishing operations.

In order to ensure that the quota is not exceeded, NMFS observers will be used to obtain scientific and biological information and monitor the number of porpoises that are killed by the fishermen.

NOAA-U.S. Navy Start Ice Forecasting Center

The U.S. Navy and the National Oceanic and Atmospheric Administration (NOAA) are establishing a Joint Ice Center for the forecasting and reporting of ice formations in the waters of the Northern Hemisphere, the agencies have announced.

Moving to meet an expected increase in need for ice information as resources of the Alaskan area are further developed, the two agencies will pool existing activities, to be located at the Navy's Fleet Weather Facility in Suitland, Md.

The Joint Ice Center will provide ice forecasts and advisories to support activities of the Department of Defense, and also will provide advisories and guidance to NOAA's National Weather Service. The guidance will be used by the NWS forecast office in Fairbanks, Alaska, to prepare ice forecasts for Alaskan area waters.

Two other elements of NOAA—a Commerce Department agency—will contribute to the Center; the National Environmental Satellite Service and the Environmental Research Laboratories.

The satellite arm of NOAA will make available ice pictures and interpretation from its polar-orbiting satellite system, while the Pacific Marine Environmental Laboratory in Seattle, Wash., will develop improved short-range (3- to 5-day) forecasts through numerical modeling, and longer-range ice "foreshadowing" through climatological studies.

Supporting studies of ice dynamics will be done under contract to the Seattle laboratory by AIDJEX, the National Science Foundation-Office of Naval Research Arctic Ice Dynamics Joint Experiment.

The Navy, which has conducted research into ice formation and movements for several decades, will perform aerial ice reconnaisance from both Navy and civil aircraft flying over the Arctic ice fields.

Research and development activities in the past by the Navy have established a solid foundation of knowledge about ocean ice phenomena, contributing significantly to the quality and reliability of ice forecasting.

Skamania Salmon Hatchery Gets Anti-Pollution Funds

A $475,000 contract for the State of Washington Department of Game to construct pollution abatement facilities at its Skamania Hatchery has been awarded by the National Oceanic and Atmospheric Administration (NOAA). In operation since 1957, the Skamania Hatchery is located in the Lower Columbia area in the western foothills of the Cascade Range, and produces between 90,000 and 130,000 pounds of summer steelhead trout juvenile fish each year.

Construction at the Skamania Hatchery will include two 6 × 22.5 × 60-foot sedimentation ponds, relocation of spawning ponds, extensive replumbing of the water supply, and pond cleaning lines throughout the hatchery.

Some of the sludge collected in the sedimentation ponds will be used for fertilizer on state hatcheries and forest grounds. The remainder of the sludge will be deposited in sanitary land fills.

The hatchery at Skamania is one of 21 State and Federal hatcheries funded by the Commerce Department's NOAA and its National Marine Fisheries Service under the Columbia River Fisheries Development Program. Undertaken in 1948, the program aims to reduce the losses of salmon and steelhead trout caused by Federal Water Development Projects. Construction at Cascade is part of a continuing effort to provide pollution abatement facilities at all Columbia Basin Fish Hatcheries funded by NOAA.

Other Columbia Basin hatcheries funded by NOAA where abatement facilities have already been constructed are Kalama State Hatchery in Washington, and Eagle Creek National Fish Hatchery and Gnat Creek State Hatchery in Oregon.

USSR Fishing Fleet Told to Conserve Butterfish

The Soviet fishing fleet off the Atlantic Coast of the United States has been instructed by the Russian Deputy Minister of Fisheries to conserve butterfish stocks in those waters. Additionally, Soviet fishing captains have been told to adopt all reasonable measures to insure the safe transfer at sea of U.S. personnel boarding Russian vessels for inspection purposes.

These were among matters discussed between Soviet and United States officials in early March in New York. Representing the U.S. Commerce Department was Carmen Blondin, Assistant Director of the Office of International Fisheries, National Marine Fisheries Service, while Iurii A. Znamensky, Fisheries Attache with the Soviet Embassy in Washington, represented the USSR. Also attending were members of the U.S. Coast

Guard, NMFS personnel, and three Soviet fleet managers in charge of fishing operations off the U.S. coast.

The fleet managers stressed that Russian fishermen had been advised that when fishing for Atlantic hake, after the first trawl resulting in incidental take of butterfish, they must release the trawl in its entirety. If butterfish are caught on the second haul, the vessels must leave the area and fish for hake elsewhere.

The meeting included discussion of the new 200-mile limit regulations which became effective 1 March, and which already apparently have affected the number of Soviet vessels fishing off the Atlantic coast. Last year in March, 91 USSR fishing vessels were sighted off the coast from Maine to Cap Hatteras, while this year, as of 4 March, there were only 11 stern factory trawlers and four support vessels in these waters.

February Drop in Foreign Fishing off U.S. Coasts "Probably Due" to FCMA

The 314 foreign fishing and fisheries support vessels sighted off the U.S. coast in February reflected a decrease from February 1976, when 510 vessels were sighted, according to preliminary reports of the National Oceanic and Atmospheric Administration. The decrease was probably due to the impending start of the new "200-mile limit" that became effective 1 March 1977. February was the last month foreign fishermen could fish without a permit issued under the Fishery Conservation and Management Act (FCMA) of 1976.

The total number of sightings represented a decrease of 196 from the number of vessels seen off the U.S. coasts in February of 1976. The counts were made by representatives of the Commerce Department agency's National Marine Fisheries Service and by personnel of the U.S. Coast Guard, conducting joint fisheries enforcement patrols from Coast Guard aircraft and cutters. The ships included in the total were within 200 miles of the U.S. coast and came from 13 foreign nations.

The largest number of foreign fisheries vessels, 148, were from the Soviet Union, which had 94 ships off Alaska, 50 off New England, and 4 off the Mid-Atlantic. Second was Japan with 77, of which 57 were off Alaska, 10 off New England, 5 off the Mid-Atlantic, and 5 off the southeast coast. Third was Spain with 21, of which 11 were off the Mid-Atlantic and 10 off New England. Poland was fourth with 16 off the Mid-Atlantic.

In addition, Coast Guard and NMFS personnel sighted vessels from the German Democratic Republic (East Germany), the Republic of China (Taiwan), Bulgaria, Nigeria, Cuba, South Korea, Ireland, Italy, and Panama.

A summary of foreign fishing vessels operating off the U.S. coasts during February 1977 is given in the accompanying table.

Area	Nation	No. of vessels
Off New England	Soviet Union	50
	Japan	10
	Spain	10
	Cuba	4
	Italy	2
		76
In the Middle Atlantic	Poland	16
	Spain	11
	Italy	8
	East Germany	6
	Japan	5
	Soviet Union	4
	Bulgaria	3
	South Korea	2
	Ireland	1
	Nigeria	1
		57
Off the SE coast	Japan	5
Off the West Coast	South Korea	11
	Panama	7
	Taiwan	7
		25
Off Alaska	Soviet Union	94
	Japan	57
		151
	Total	314

Note: Foreign vessels sighted off the coasts in 1976 were as follows: January, 420; February, 510; March, 435; April, 610; May, 928; June, 970; July, 842; August, 543; September, 514; October, 452; November, 258; December, 240. In January 1977, 319 foreign vessels were sighted off U.S. coasts.

NOAA Grant Aids Culebra Restoration

Bombarded by Navy ships and aircraft for nearly 40 years, the tiny Puerto Rican island of Culebra will be a step closer to restoration as a natural scenic

area with a grant of $295,000 made on 15 April in San Juan by the Commerce Department's National Oceanic and Atmospheric Administration (NOAA). The grant is for administration of the Culebra segment of Puerto Rico's coastal zone management plan. A Certificate of Approval for the Culebra segment was also awarded to Governor Carlos Romero Barcelo of Puerto Rico by Robert W. Knecht, NOAA's Acting Associate Administrator for Coastal Zone Management.

Culebra is about 7 miles long by 3½ miles wide, and has a population of nearly 1,000. It lies about 17 miles east of Puerto Rico. The U.S. Navy established a target range on part of the island in 1936, and used the range continuously until 1975.

Little water is available on Culebra, restricting possible population increases, but a great deal of natural beauty makes limited tourism a possiblity. In addition, Culebra provides nesting sites for two species of turtles that are listed as endangered, the hawksbill and leatherback, and two that have been proposed for threatened status, the loggerhead and the green sea turtle.

The Culebra segment is the first part of the Commonwealth of Puerto Rico's coastal zone management plan to win approval as meeting the requirements of the Coastal Zone Management Act of 1972. The Culebra program will be integrated into the Commonwealth's overall program in the formal submission of the Puerto Rico document to NOAA in December 1977.

The NOAA grant will be used to rehabilitate disrupted areas and to protect the island's unique natural resources. A portion of the funds will be used to survey the target areas to locate unexploded shells and bombs, and to post and patrol the hazardous areas.

Provisions for conserving and preserving Culebra's wildlife and other natural resources also are included in the management plan. In addition, procedures are set forth for meeting the problem of relocation housing for permanent and temporary residents who, in certain areas, have constructed dwellings on Federal lands or land that may be in dispute.

Wolfe Chosen for OCSEAP Program

Douglas Wolfe, a marine pollution ecologist and specialist on trace elements in marine shellfish, has been appointed deputy director for the Outer Continental Shelf Environmental Assessment Program (OCSEAP) of the National Oceanic and Atmospheric Administration, in Boulder, Colo.

Wolfe formerly represented NOAA's National Marine Fisheries Service in the management of research for OCSEAP, which is a major environmental study directed by the Commerce Department agency's Environmental Research Laboratories for the Interior Department's Bureau of Land Management. The comprehensive OCSEAP study seeks to determine the probable ecological impacts of oil exploration and development activities on Alaska's outer continental shelf.

Previously, Wolfe was Division of Ecology Director for NOAA's Atlantic Estuarine Fisheries Center on Pivers Island, N.C., and an adjunct associate professor of zoology at North Carolina State University in Raleigh. He joined the Commerce Department in 1964 after completing work for his Ph.D. in physiological chemistry at Ohio State University, where he also received a B.S. in zoology and an M.S. in physiological chemistry. He has authored more than 50 scientific publications.

Vessel Economics Studied in Major U.S. Fisheries

Profits and losses of commercial fishing vessel operations in major U.S. fisheries during periods of rising costs of fuel and oil products are analyzed in a report just issued by the National Oceanic and Atmospheric Administration (NOAA). Prepared by the Commerce Department agency's National Marine Fisheries Service, the analysis evaluates the earning potential of vessel operations in specific U.S. fisheries of the Atlantic, Pacific, and the Gulf of Mexico.

These fisheries accounted for 65 percent by quantity and 68 percent by value of total U.S. food fish landings in 1974. A total of 297 vessel-years of operation was analyzed by fishery: groundfish, 54; salmon, 124; tuna, 29; shrimp, 61; and crab (king and tanner), 29 vessel-years.

The report, **Revenues, Costs, and Returns From Vessel Operation in Major U.S. Fisheries,** covers the following fisheries: groundfish, New En-

Summary of vessel earnings, by fishery, region, gear type, and vessel size.

			Average values			Fuel costs relative to gross revenue (%)
Fishery	Region	Gear type	Vessel size (GRT)	Gross revenue ($)	ROI (%)	
Groundfish—Atlantic	New England	Otter trawl	32	56,397	−6.3	11.0
Groundfish—Atlantic	New England	Otter trawl	52	137,584	−6.5	7.3
Groundfish—Atlantic (industrial fish)	New England	Otter trawl	87	231,015	9.6	4.9
Groundfish—Atlantic	New England	Otter trawl	176	227,548	0.8	9.2
Groundfish—Pacific	California	Otter trawl	42	80,833	6.2	7.4
Groundfish—Pacific	California	Otter trawl	79	138,164	5.6	7.5
Groundfish—Pacific	Oreg., Wash.	Otter trawl	55	100,989	8.3	6.5
Groundfish—halibut	Calif., Wash.	Longlines	51	173,892	0.7	8.6
Salmon	Oreg., Wash., Alaska	Purse seine	28	80,396	22.2	1.1
Salmon	Oreg., Wash., Alaska	Purse seine	46	113,524	21.3	1.8
Salmon	Oreg., Wash., Alaska	Troll lines	14	15,146	4.3	6.2
Salmon	Oreg., Wash., Alaska	Troll lines	17	32,547	20.8	4.5
Salmon	Oreg., Wash.	Gill net	11	20,785	21.0	4.8
Salmon	Alaska	Gill net	11	23,093	30.2	4.6
Salmon (halibut)	Oreg., Wash. Alaska	Troll lines, gill net, longlines	25	41,912	13.4	3.6
Salmon (dungeness crab)	Oreg., Wash.	Troll lines, gill net, pots	21	46,879	23.9	3.4
Salmon (albacore)	Oreg., Wash., Alaska	Troll lines	17	18,908	9.5	5.3
Salmon (albacore)	Same	Troll lines	31	31,746	10.6	4.3
Salmon (albacore, dung. crab)	California	Troll lines, pots	21	26,154	12.3	6.1
Salmon (albacore, dung. crab)	California	Troll lines, pots	44	47,043	8.2	7.1
Salmon (albacore, dung. crab)	Oreg., Wash.	Troll lines, pots	26	36,648	11.4	5.3
Salmon (albacore, dung. crab, shrimp, groundfish)	Oreg., Wash.	Otter trawl, pots, salmon gear	50	82,295	5.2	3.3
Salmon (albacore, dung. crab, shrimp, groundfish)	Oreg., Wash.	Otter trawl, pots, salmon gear	100	160,156	11.7	4.8
Salmon (albacore, dung. crab, shrimp, groundfish)	Oreg., Wash., Alaska	Otter trawl, pots, salmon gear	24	27,553	2.8	4.8
Tuna—albacore	Calif., Oreg.	Troll lines	34	48,692	5.0	9.0
Tuna—tropical	California	Pole and line	102	239,687	13.5	7.3
Tuna—tropical	California	Purse seine	319	599,910	2.6	6.8
Tuna—tropical	California	Purse seine	721	980,362	2.5	12.7
Tuna—tropical	California	Purse seine	1,039	1,554,434	7.2	11.7
Crab—king & tanner	Alaska	Pots	140	339,276	14.9	5.0
Crab—king & tanner	Alaska	Pots	198	493,305	19.8	6.3
Crab—king & tanner (salmon)	Alaska	Pots, purse seine	51	142,834	11.0	5.0
Shrimp	Gulf of Mex.	Otter trawl	60	43,482	−9.6	16.7
Shrimp	Gulf of Mex.	Otter trawl	108	98,014	−0.3	17.7

Note: In parentheses—other species fished for.

gland and the entire Pacific coast, including halibut fishing; Pacific salmon; tuna, albacore and tropical; shrimp, Gulf of Mexico; and crab, northeast Pacific and Bering Sea. Data for the report were provided by vessel operators participating in various programs of the National Marine Fisheries Service.

The rate of return on investment varies greatly among groups of vessels operating in these fisheries, depending upon many factors such as size of vessels, type of fishing gear, target species, and location of the fishery. The rate ranges from a low of minus 9.6 percent for a group of shrimp trawlers in the Gulf of Mexico to a high of 30.2 percent for a group of salmon gillnetters in Alaska.

Vessels in a particular fishery demonstrate the average rates of return on investment (ROI) and relative fuel costs in the table at right.

Generally, low rates of return on investment for a vessel group are associated with high fuel costs. Groundfish trawlers in New England, shrimp trawlers in the Gulf of Mexico, some tuna vessels (trollers and purse seiners), and halibut longliners are known to have high fuel consumption because of their fishing systems, or because of long distances to the fishing grounds.

Although there are a few exceptions, salmon vessels that operate close to their home ports reflect the highest rate of return on investment and the lowest relative cost of fuel.

Fishery	ROI	Fuel Cost Relative to Gross Revenue
Shrimp, Gulf[1] (61)	−0.8%	17.6%
Halibut, Pac. (7)	0.7	8.6
Groundfish, Atl. (29)	1.2	7.8
Tuna (29)	5.6	10.7
Groundfish, Pac. (18)	6.7	7.2
Salmon, combination vessels (85)	10.6	5.0
Crab, king and tanner (20)	16.5	5.4
Salmon (48)	19.9	2.8
All fisheries (297)	7.0	9.3

[1]Figures in parentheses indicate the number of vessel-years in the sample.

Commerce Department Cites McDonald's for Fish Effort

A national restaurant chain has received a certificate of recognition from the Department of Commerce for participation in a nationwide consumer education effort on behalf of the Department's Voluntary Fishery Products Inspection Program.

In early March the McDonald's[1] restaurant chain started a program to inform consumers that it uses USDC inspected, Grade A fish portions exclusively in the fish sandwiches sold throughout its 3,700 U.S. fast-food outlets. McDonald's restaurants serve more than 42 million pounds of USDC Grade A fish portions each year.

This is the first time that a restaurant or restaurant chain has helped the Department of Commerce educate consumers about the availability and significance of USDC-inspected products. The Voluntary Fishery Products Inspection Program is carried out by the National Marine Fisheries Service, an agency of the Department's National Oceanic and Atmospheric Administration.

McDonald's Director of Quality Assurance, Victor Wortman, said the restaurant chain strongly supports the program, which encourages the fishing industry to assure the safety and improve and maintain the quality of its products through inspection and standardization procedures, usually carried out by Federal inspectors.

The certificate was presented by Under Secretary of Commerce designate Sidney Harman. Other Commerce officials at the presentation included Robert M. White, NOAA Administrator, David H. Wallace, Associate Administrator for Marine Resources, NOAA; Robert W. Schoning, Director, National Marine Fisheries Service, NOAA; Joseph W. Slavin, Assistant Director for Fisheries Development, NMFS; and Thomas J. Billy, Chief, Seafood Quality and Inspection Division, NMFS.

[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

"Floatables" Surveyed in New York Bight

You get out of an ocean what you put into it, according to National Oceanic and Atmospheric Administration (NOAA) scientists reporting on the massive June 1976 contamination of Long Island ocean beaches.

Citing many probable sources of the materials which littered area beaches a year ago, the NOAA researchers conclude that such incidents will continue, given present techniques for handling wastes and their associated "floatables"—the unsinkable, resilient artifacts of modern civilization. The Commerce Department agency scientists also point out that, although affected beaches were closed as a precautionary measure, water tests showed no serious degradation of water quality during the incident. And they found only a slight contribution to the pollution episode by sewage sludge dumping in the ocean south of New York.

The NOAA report, "Long Island Beach Pollution: June 1976," was prepared by NOAA's Marine Ecosystems Analysis (MESA) New York Bight project; the U.S. Environmental Protection Agency, Region II; and the U.S. Coast Guard, Third District, Marine Environmental Protection Branch. A kind of environmental detective story, it links seemingly unrelated pollution events across the New York metropolitan area, and unusual atmospheric conditions, with the floatables incident.

The pollution of Long Island's south shore was greatest from 14 to 21 June 1976, when beaches were heavily contaminated by a wide variety of floating litter. Floatables were dispersed over some 7,500 square nautical miles (25,700 square kilometers) of the New York Bight, a 15,000-square mile (39,000 km^2) area reaching from an apex off New York City to the edge of the continental shelf. This seaborne litter was driven ashore by unusually persistent winds from the south. Any materials that entered the Bight just before and during the 12-day period of these winds could have been washed onto the beaches.

Many types of floatable material

were found on the beaches, including garbage, trash, charred wood, oil, plastics, rubber, and grease. The last three types of floatable are usually associated with sewage treatment facilities, according to the NOAA report. There was no confirmation of early claims that raw sewage had washed up on the beaches. Analysis of tar and grease balls found among the litter generally did suggest a sewage origin for at least part of the substances included in them, but the report notes, water quality at the beaches was tested and remained well within established standards for swimming.

A major source of the grease and sewage found in the pollution incident appears to have been chronic release of material into the Bight. The report notes that untreated sewage is routinely discharged from some areas during repair or construction. In May and June 1976, an estimated 428 million gallons (1.6 billion liters) of raw sewage were discharged this way. The researchers also estimate some 300,000 to 400,000 pounds (136,000 to 181,000 kilograms) per day of oil and grease enter the Bight from the discharge of the Hudson-Raritan estuarine system.

New York, like most large cities, combines its storm runoff and sewage systems. When the combined flow is too much for a treatment plant, the overflow bypasses the plant and is discharged untreated. This runoff also contains trash, grit, and oil from city streets. It is estimated that rainfall of only 0.04 of an inch or more in the metropolitan area exceeds treatment plant capacity and leads to the bypassing of the plant in the release of untreated wastes. During late May and June 1976, rainfall exceeded 0.04 inch (1.02 mm) at Central Park on 19 days.

The Hudson River flow, above normal during May, reached a peak of 719,000 cubic feet (20 million liters) per second on 20 May, a volume exceeded only once in the past 16 years. High river runoffs typically bring large quantities of pollutants into the Bight from outfalls and other sources upstream, and tend to distribute floatables over a wide area of the Bight, according to the report.

The NOAA investigators believe the June pollution incident could also have been influenced by events occuring as early as 8 May, when a medium oil spill in upper New York Bay resulted in large quantities of black tar balls washing up on beaches from Jacob Riis Park to Fire Island. Although this pollution was cleaned up by the end of May, residual oil remaining in the water could have contributed to formation of tar and grease balls later on.

On 26 May, an oil storage tank ruptured at Jersey City, N.J., spilling 3 million gallons (11.4 million liters) of number 6 oil, of which about 150,000 gallons (568,000 liters) reached the Hackensack River, with large quantities remaining in the wetlands of Hackensack Meadows. The Coast Guard cleanup of this spill was completed 2 days later; but, again, some oil could have remained in the environment to help form the tar and grease balls observed in June.

On 2 June, two sewage sludge storage tanks containing some 2.7 million gallons (10.2 million liters) of "digested" sludge exploded on Pearsalls Hassock, and an estimated 1 million gallons of sludge flowed into the water. Soon afterward, the Coast Guard observed material floating out to sea through East Rockaway Inlet. The researchers see it as a possibly important source of certain plastic artifacts and other nondegradable sewage-related objects.

Other possible contributing events included pier fires at Weehawken, N.J., and Manhattan in early June. These fires were the apparent source of charred wood that washed onto the beaches.

"We have a sequence of events that seems to have culminated in the beach pollution episode," explains NOAA Commander Lawrence Swanson, who directs the New York Bight Project from its field headquarters in Stony Brook. "Clearly, some sources were more important than others. But we really can't assess the contribution of each event except in a general way.

"The fact is that nondegradable plastic floatables are being introduced into the environment much faster than the environment can assimilate them. This isn't just a New York problem. It's a national problem."

Long Island Beach Pollution: June 1976 is available in limited quantities from the MESA New York Bight Project Office, Old Biology Building, SUNY, Stony Brook, NY 11794.

NOAA Scientists Measure Petroleum in Puget Sound

An intensive study of petroleum found in the sediments and mussels in the Strait of Juan de Fuca and northern Puget Sound was started in March, to determine existing conditions, and to help assess any changes caused by future oil spills in the Sound. The study is being conducted by scientists with the National Oceanic and Atmospheric Administration (NOAA) in Seattle.

Four times this year a total of more than 200 samples of sediments and mussels will be collected at a score of shoreline sites for analysis at NOAA's National Analytical Facility in Seattle. The study is funded by the Environmental Protection Agency and managed by NOAA's Marine Ecosystem Analysis program office, part of the Commerce Department agency's Environmental Research Laboratories. It is part of a larger study of all aspects of the environment that might affect, or be affected by, petroleum pollution.

The waters of this region—from Neah Bay to the beaches near refineries on the Washington mainland—have remained relatively unpolluted by oil. But tanker traffic in the Sound is expected to increase substantially over the next few years, and the area may become a port for transfer of Alaskan oil from ship to cross-country pipelines. This increased traffic will bring increased risks of spills and small-scale leaks.

Sediments and mussels were chosen for study because they are good indicators of oil pollution, and are easily collected throughout the Puget Sound region, according to Howard Harris of the MESA office. Along the shore, researchers from the Analytical Facility will collect sediment and mussel sam-

ples at several intervals just above the mean lower low-water point of the tide. The mean lower low-water level is an average of the lowest points reached by the tides each day.

During each sampling, the researchers will record the existing tidal stage, wave exposure, weather conditions, and temperatures of air, water, and sediment. The sampling site will be photographed each time, and the investigators will record a general description of the site, including nearby likely sources of petroleum, and will note whether the water has an oil-like sheen, visible floating oil, or stranded oil, and whether there are unusual numbers of dead animals.

Chemists at the analytical facility will weigh the samples, record the texture and color of the sediments, and test them for a long list of chemical constituents of oil and for organic carbon.

Another part of the study will focus on the effects of sampling methods and natural variability across the beach on the measured hydrocarbon level. Later, the researchers may look at other constituents of petroleum and at metabolic products.

Bowhead and Beluga Whales Counted in Arctic

The first systematic count of two species of Arctic whale—the large, endangered bowhead and the smaller, white beluga—begun last spring (1976) on the Arctic ice pack, was resumed in April by biologists with the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS).

The survey is part of a major environmental study being conducted by NOAA's Environmental Research Laboratories for the Interior Department's Bureau of Land Management. The study will establish environmental baselines and help Federal managers determine the probable impact of petroleum development on Alaska's outer continental shelf.

Bowhead and beluga whales are important players in the ecological drama off Alaska, but their movements cross such difficult environments that they have not been closely observed by scientists. Because they are air-breathing mammals and migrate along leads (long openings) in the ice pack usually close to shore, they also are believed to be particularly vulnerable to the potential environmental effects of Arctic energy development activities.

The whale count is being performed by NMFS biologists with the Marine Mammal Division of the Commerce Department agency's Northwest and Alaska Fisheries Center, Seattle, Wash.

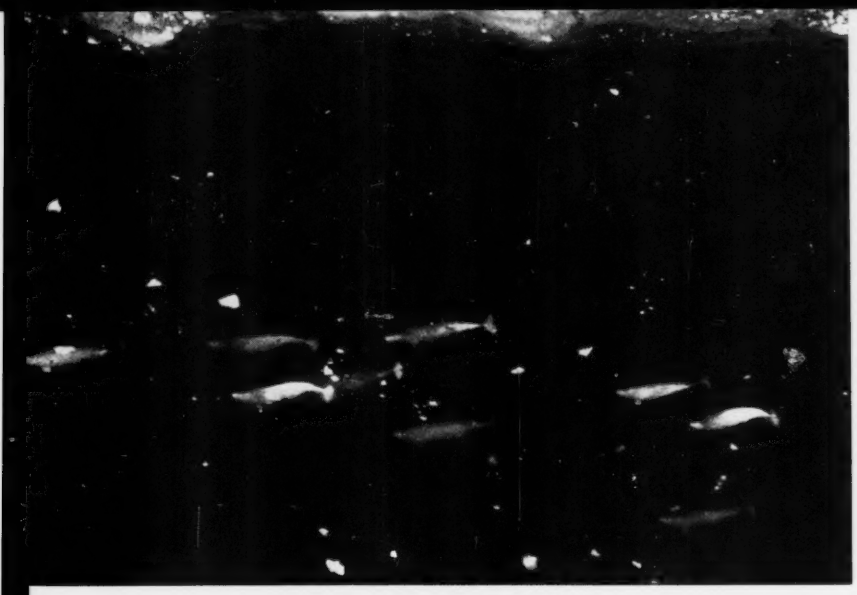
"Until now," according to Howard Braham, the biologist leading the whale study, "bowheads and belugas have been considered more or less uncountable. The count we took from April to early June of last year was the first systematic look anyone has ever taken at these species."

The 1976 spring work counted more than 1,300 belugas and more than 350 bowheads. The survey was made by biologists at camps near leads through the floating sea ice, and from aircraft from the Naval Arctic Research Laboratory (NARL) in Barrow. The ice camps are moved according to ice conditions, and usually located near the Eskimo whale harvest camps. Aerial surveys avoid the harvest camps, but follow leads, where scientists count whales visually and photograph them.

The second spring census, which began in April, placed one ice camp seaward of Barrow and another off Point Hope, northeast of the Bering Strait. "This year," Braham said, "we'll be collecting more sighting data in an effort to see if we can estimate

Ice hummocks (left) were made by beluga whales when they surfaced to breathe under thin ice.

The bowhead whale, *Balaena mysticetus*, below.



Beluga whales, *Delphinapterus leucas*.

total beluga and bowhead abundance. But all we have to go on at present are historical whaling records and feelings." The NOAA scientists also want to refine what is known of the two whale species beyond a population count, and to assess the probable impact on them of oil and gas development off Arctic Alaska.

"We don't know, for example," Braham explained, "how many of these whales migrating up through the Bering Strait continue north into the Chukchi Sea, or how many turn east into the Beaufort Sea. North of the Strait, they may all migrate through the Hope Basin oil lease area. We need to know how many of them also migrate through the Beaufort lease area and what proportion of these are mothers and calves. The ice camp at Point Hope will help us answer some of these questions."

Braham noted that even less is known about the movements of bowheads and belugas in autumn and winter. "We did some aerial work last autumn in the Beaufort Sea," he said, "but, because of poor weather, saw very few bowheads."

The bowhead whale, also called the Greenland right whale, is a large cetacean up to 60 feet (20 m) in length, and dark brown to black in color. It is distinguished by an enormous head about one-third of the whale's total length. Overhunting of Alaska bowheads had already pushed their numbers into serious decline by the late 19th century, and today they are designated as an endangered species. No longer commercially harvested, bowheads are still the subject of seasonal native harvests from small sealskin boats.

Beluga whales are white when adult, about 18 feet (6 m) in length, and are more numerous than the bowhead. More gregarious than the larger bowheads, belugas often congregate in "pods" of 20 or 30 individuals.

FCMA Report Issued By Commerce Department

Actions taken by the eight Regional Fishery Management Councils and the Department of Commerce to implement the Fishery Conservation and Management Act (FCMA) of 1976 are summarized in a report sent to Congress earlier this year by the Department of Commerce. The report covers the period 13 April-31 December 1976, during which preparations were made to insure that the United States would be prepared to exercise its management authority of the 200-mile limit on 1 March 1977.

Members of the Councils were appointed in mid-August, began meeting in late September and early October, and by the end of the year had elected officers and, in many cases, had selected executive directors and administrative headquarters. Scientific and statistical committees were established and the Councils began evaluating the fishery resources within their areas, and reviewed and provided comments on matters and documents associated with management of foreign fishing.

In addition to processing nominations for Council membership, conducting an orientation conference, and issuing regulations and an operations manual on Council activities, the National Marine Fisheries Service of the Commerce Department prepared 16 preliminary fishery management plans. The plans identified those portions of the optimum yields of fisheries that could be allotted to foreign fishermen.

Other major actions were undertaken with the cooperation of the Department of State and the U.S. Coast Guard. Six Governing International Fishery Agreements were signed and others were being negotiated by the end of the year. In addition, forms for foreign permits and permit applications were developed, a proposed fee schedule prepared and published, and enforcement and surveillance requirements assessed to insure compliance with the Act.

The activity report contains detailed information on actions taken regarding the formation of the Fishery Management Councils, fishery management, and interagency activities. It also discusses the accomplishments of the eight Regional Fishery Management Councils, and lists membership of the Councils and the administrative staffs, committees, and panels. A copy of the report may be obtained from the National Marine Fisheries Service, NOAA, Washington, DC 20235.

Fish-Kill Warning Signs Sought Off New Jersey

National Oceanic and Atmospheric Administration (NOAA) scientists are conducting a series of research cruises off the New York-New Jersey coast, to

detect any early environmental signals that could bring another fish kill this summer, as happened last year. Conducted as part of NOAA's Marine Ecosystems Analysis (MESA) New York Bight Project, the series of nine voyages by the NOAA ships *Kelez* and *Delaware II* coincide with critical seasonal points in the Bight's cycle of plant life, nutrient chemicals, and water motion. The first cruise was completed in February, with the remainder running through the fall.

Scientists aboard the Commerce Department agency's ships will be searching, in particular, for early indications that waters in the Bight are beginning to stratify—that is, become persistent, stable horizontal layers—as they tend to do during the summer.

Because stratification inhibits vertical mixing, it reduces the flow of life-giving oxygen from surface waters to the colder waters near the bottom. Last year NOAA researchers found that the demand for oxygen in these deep waters exceeded the supply, creating suffocating low-oxygen, or "anoxic," conditions for Bight creatures unable to move out of the area.

There is evidence that dissolved oxygen in Bight waters decreases annually, beginning usually in April. But in most years, new water entering the Bight from other areas, and the water-stirring storms of late summer, break up the stratified layers before the oxygen in the water has been completely consumed. In those years—and this is the usual case—no fish kill occurs.

But stratification and a decline in dissolved oxygen concentration in February or early March could signal the potential for another fish kill this year.

Whether a fish kill comes or not depends on several other key elements, according to NOAA Corps Commander Lawrence Swanson, who heads the MESA New York Bight Project from headquarters at Stony Brook, N.Y. "Early stratification and a decline in dissolved oxygen are important signals," he said," but by themselves they don't necessarily forecast a fish kill. The *Kelez* cruises will alternately monitor chemical properties of the water column, and the other critical elements we believe are necessary to produce such kills."

Those critical elements, Swanson explained, are a seasonal bloom of phytoplankton, and the flow of nutrients—mainly from sources up the Hudson-Raritan River systems—which feed the bloom and which, last year, apparently caused a population explosion among the marine plants.

"We believe," he said, "that the anoxic event last summer was caused primarily by an unusually large phytoplankton bloom in the Bight. As the plants died off, they sank to the bottom. Their decomposition there placed intolerable demands on the supply of dissolved oxygen.

"At the same time, intense stratification isolated the bottom waters from oxygen nearer the surface, and persistent offshore winds delayed the usual exchange of water through the Bight. These conditions led to the fish kill."

Thus, scientists aboard the *Kelez* will also be studying the phytoplankton-nutrient cycles in the Bight, with an eye to predicting such conditions.

The first two cruises, led by scientists from the Sandy Hook, N.J., laboratory of NOAA's National Marine Fisheries Service, looked for early indications that stratification then could lead to a problem later in the year. No evidence of early stratification was found.

An April-May voyage, led by scientists from the Ocean Chemistry Laboratory of the Atlantic Oceanographic and Meteorological Laboratories (like the MESA program, part of NOAA's Environmental Research Laboratories) in Miami, Fla., studied water-column chemistry in the Bight. This coincided with the seasonal point when stratification usually begins to set up, and also provided observations just before Memorial Day Weekend, when area beaches became active.

A cruise in May, led by Tom Malone of the Lamont-Doherty Observatory, focused on the phytoplankton bloom process, and the flow of nutrients—particularly nitrogen—into Bight waters. Other studies of the phytoplankton-nutrient relationship were scheduled for cruises in late July and in November.

In late May and early June, another water-column chemistry cruise was scheduled as is a third in August, when one would expect to see anoxic conditions if these developed this year. The August voyage also will add to a data base of dissolved-oxygen, temperature, and salinity values going back to 1948. This long record will permit the researchers to study historical trends of these properties in the Bight.

A fourth water-column cruise in October will observe the seasonal breakup of the stratification in Bight waters, providing insights into how rapidly this occurs, and what it means in terms of oxygen and other chemical constituents.

U.S. Observers Put On Foreign Fishing Boats

The first U.S. observers have been placed on foreign fishing vessels that are permitted to fish within the 200-mile fishery conservation zone, according to the National Oceanic and Atmospheric Administration's National Marine Fisheries Service.

Four observers from the Commerce Department agency boarded two Japanese crab factory ships when the ships sailed from Hokkaido, Japan, earlier this year, bound for the eastern Bering Sea. They will remain on the ships until the Japanese reach their quota of 12,500 metric tons of tanner crabs, probably in July.

Under the terms of permits issued under the Fishery Conservation and Management Act of 1976, observers are placed on foreign fishing vessels to collect biological data, information on their catch, information on the types of gear used, and information on the fishing effort of the vessels. In addition, they will monitor compliance with the regulations and terms of the fishing permit.

Observer trips will cost between $2,000 and $10,000, including all direct and management overhead support costs of the Department of Commerce, Coast Guard, Navy, and Customs Service. These costs will be paid by the foreign nations which have observers on board their ships.

Canada Charts $41 Million Course Toward Fisheries Prosperity

A $41 million fisheries rebuilding program for 1977-78 will increase the value of the inshore fishery and build up Canada's offshore fishing effort in the new 200-mile zone, Roméo LeBlanc, Minister of Fisheries and the Environment, has announced.

Aimed mainly at the Atlantic coast, this year's measures form part of a long-term effort to rebuild the fishing industry into overall prosperity. The federal government had previously authorized around $130 million for emergency aid since mid-1974 to keep major sectors of the fishing industry alive, particularly the groundfish[1] industry, the mainstay of east coast fisheries. The new program cuts back direct financial assistance and introduces concrete measures to strengthen weak sectors of the chronically troubled fishing industry, according to LeBlanc.

"We are changing the emphasis from rescue to rebuilding," LeBlanc said. "With the new 200-mile zone, we're now in a position to manage our fishery resources properly. Our programs will also touch historic shortcomings of the industry which had no relation to the 200-mile limit."

This year's program follows policy directions announced last year in the publication "Policy for Canada's Commercial Fisheries[2]". Specific projects for 1977-78 mostly originated with the regional directorates of the Fisheries and Marine Service, following consultations with fishermen and processors on regional needs.

The program particularly benefits inshore and nearshore fishermen in the fleet of more than 25,000 intermediate and small boats on the Atlantic coast. Measures will also assist the large-trawler fleet of some 160 vessels to increase offshore fishing and to move towards taking all the available catch within the Canadian zone.

[1]Groundfish are cod, haddock, and similar "whitefish" species which feed near the ocean bottom.

[2]Available from the Information Branch, Fisheries & Marine Service, Ottawa, Ontario K1A 0H3.

The 1977-78 program falls into four sections: 1) Increasing the value of the fish; 2) fishing new grounds and new species; 3) fishing fleet changes; and 4) marketing.

INCREASING THE VALUE OF THE FISH

Inshore Fishery

In the inshore fishery, a major effort to improve the quality of fish landings could raise the inshore fishery's value by 30-40 percent in many areas. Loss of quality has been a severe problem in the handling of inshore fish in some areas on the Atlantic coast because of lack of ice facilities, poor handling practices, pitchforking fish from boat to dock, and so on. In Newfoundland alone, upgrading quality and improving yield could increase usable landings by 18 million pounds and raise production value by $22 million annually. The three major projects will raise fish quality and prices.

Newfoundland

In Newfoundland the federal Fisheries and Marine Service will initiate a 4-year, $13 million program (of which $3.6 million will be spent this year) to provide a new fish-handling system at 200 communities where 85-90 percent of inshore-caught fish are landed. The system is simple, low cost, and provides a fast discharge rate, important for preserving quality during the peak fishing season when air and water temperatures are high. Net bags layered in with the fish are unloaded by a dockside hoist that automatically weighs each bag.

On the dock, the fish go into a hopper that controls their flow across a sorting table; they are then iced into large insulated containers for storage on the wharf or immediate loading by a lift onto transport trucks. This new system will ensure the delivery of first quality fish to the processing plants.

Tests at five communities produced excellent results and good acceptance

Maritime Fish Landings Down, Value Up in 1976

Preliminary Canadian statistics indicate that total landings in the Maritime Provinces off Canada's Atlantic coast in 1976 were 476,352 metric tons (t) round weight, valued at C$136.1 million (at C$1.00 = US$0.98), an all-time record for landed value. In 1975, landings totaled 482,542 t and were worth C$123.4 million.

As in 1975, total groundfish landings in 1976 continued to decline though cod landings increased by 3,619 t to 54,729 t. Other figures given by Environment Canada included: pelagic and estuarial landings of 185,269 t, valued at C$18.5 million, and shellfish landings of 112,652 t, valued at C$78.4 million. Preliminary data for 1976 herring landings were 156,999 t compared to 184,316 t in 1975, a decrease of 10 percent.

Although the fishing industry in the Maritimes experienced various problems in 1976, such as high operating costs for catching and processing fish and quota restrictions, the prices paid to fishermen in 1976 compared favorably with previous years.

Source: Fisheries Statistics Branch, Environment Canada, Halifax—IFR-77/22. For complete statistics on Canadian Atlantic Coast fishery landings for 1976, send two preaddressed mailing labels to: W. L. Rodgers (F411), Office of International Fisheries, NMFS, NOAA, Commerce, Washington, DC 20235.

of the system by fishermen and processors. Federal quality standards for dockside inspection will be part of the system, enabling buyers to pay a premium price to the fisherman for first quality fish.

Maritimes and Quebec

In the Maritimes and Quebec, demonstration projects in nine communities will provide complete fish-handling systems from vessel to plant, involving more use of ice, faster unloading, and better quality-keeping at every stage.

Nationwide Program

A related nation-wide program will provide assistance for installation of commercial ice-making, ice-storing, and fish-chilling facilities on vessels or at landing sites.

Lobster Fishery

A tentative project to raise earnings in the lobster fishery would increase the size limit for lobsters in part of Lobster District 8 in New Brunswick and Prince Edward Island. Allowing one additional moult would double yield and market value. The project is under review with lobster fishermen.

Cod, Flounder, and Other Species

A series of small pilot projects will increase utilization of normally discarded flesh from cod and flounder, will develop and market canned flake and chunk mackerel packs, will use dried and ground scallop shells for animal food and fertilizer, will pursue development of a capelin roe fishery for the Japanese market, and will use ultrasonic techniques to automate detection of quality defects in fish fillets during processing.

NEW GROUNDS AND NEW SPECIES

Together with the previously announced 1977 fishing plan for the Atlantic groundfish fleet, these measures will take some pressure off the inshore fishery, where stocks have suffered from heavy fishing by large-vessel fleets, and will build up Canadian offshore fishing.

Trawlers

Trawlers of more than 100 feet length, based in the Gulf of St. Lawrence will receive assistance for fishing in waters outside the Gulf. Because of depletion of redfish and other stocks, these large vessels face severe restrictions on operations within the Gulf.

Cod Stocks

LeBlanc stressed the high importance placed on rebuilding cod stocks off Labrador and northeast Newfoundland for the benefit of both inshore and offshore fisheries. Northern fishing incentives will help develop this greatest remaining opportunity for expansion of Canadian groundfish fishing within Canada's 200-mile zone. Canadian trawlers have previously taken only a small fraction of the available catch in this area. While more Canadian fishing will replace some of the diminishing foreign effort in the area, continuing low quotas will allow a rapid rebuilding of the stocks for the inshore fishery.

Other Measures

As quotas in traditional fisheries become caught up later in 1977, incentives will help the large-vessel fleet move into other areas where they have in previous years been less active. A freezer-trawler will be chartered to determine the feasibility of using such vessels to fish nontraditional stocks in Canadian Atlantic waters, particularly for species such as silver hake and squid which spoil quickly unless frozen.

A 1-year program will carry out exploratory fishing and will develop and market products from grenadier, an Atlantic coast groundfish unfished by Canadians. A chartered stern trawler will provide the opportunity for Canadian fishermen to participate in offshore mackerel fishing, to take advantage of the sizeable resource on Brown's and George's banks off Nova Scotia in the winter months.

FISHING FLEET CHANGES

A 2-year program will subsidize conversion of the Quebec fleet of large redfish trawlers for multispecies fishing. This measure, affecting 7 of the

U.S. and Canada Sign Fishery Pact

"The United States and Canada today (24 February 1977) signed in Washington a Reciprocal Fisheries Agreement to permit continuation of fishing by fishermen of each country off the coasts of the other for 1977, following extension of their respective fisheries jurisdiction to 200 miles. The agreement was signed on the Canadian side by L.H. Legault, Director General, International Directorate, Department of Fisheries and the Environment, and on the United States side by Ambassador Rozanne L. Ridgeway, Deputy Assistant Secretary of State for Oceans and Fisheries Affairs. The agreement will enter into force upon completion of internal proceedings by both sides.

"The agreement was concluded following discussions between President Carter and Prime Minister Trudeau. The two leaders concurred that a fisheries agreement for 1977 should be concluded on the basis of the same spirit of cooperation which marked their overall discussions. They also reviewed the principles which would ensure that the interests of each in the fishing zone of the other are accommodated reciprocally for the remainder of this year.

"The two sides looked forward to longer term arrangements which are yet to be negotiated. They welcomed the signature of the agreement as an important step in the evolution of their fisheries relationship and as a contribution to their close ties as neighboring states."

fleet of 12 Gulf-based trawlers over 100 feet, will ease the pressure on the Gulf redfish fishery. Another project will convert four groundfish trawlers in the Maritimes region to replace older vessels in the scallop fleet.

MARKETING

Market development for products from dogfish, lumpfish, seal, skate, and squid will receive additional support. Funds will be set aside to aid the industry in possible efforts this year towards cooperative groupings in export marketing activities.

Conditional grants for processors of frozen groundfish for export will still be available where monthly analyses prove the need. Current projections suggest that aid will run to about half last year's level and one-third the previous year's. Although fish are still scarce, prices have risen, and the situation of those processing companies that survived recent reverses has become more stable.

Direct assistance payments will continue to groundfish fishermen supplying first quality food fish. As before, there will be no such payments on fresh fish for export. All assistance payments will be conditional on full and prompt information on costs and earnings, and will be subject to continuous review and adjustment. A program under development for this year will, where necessary, help fishermen and small plant owners to develop proper record-keeping systems; besides substantiating claims for emergency aid, good record-keeping practices will be of permanent value after the temporary assistance program ends.

Canada Restricts Joint Fishing Ventures in 1977

The Canadian Government has disclosed that it will introduce sharply restrictive policies in the area of joint ventures in the fishing industry for 1977. The new policy would, however, continue to permit experimental projects lasting no more than 1 year provided that the terms are strict and they work to the benefit of Canadian fishermen.

This decision reflects the Canadian Government's determination to plan and control fisheries programs in the newly established 200-mile fishing zone. One specific goal will be to introduce tight conservation measures for cod fishing in the waters off northeastern Newfoundland and Labrador.

In order to assure the recovery of depleted stocks, Canada is reducing the total allowable catch from 300,000 metric tons (t) in 1976 to 160,000 t in 1977. For the northern cod stock, the allocations to foreign nations have declined dramatically from 550,000 t in 1973 to 226,000 t in 1976 and 92,250 t in 1977. The clear purpose of these restrictions is to maintain or increase Canadian catches and at the same time to protect certain stocks by reducing foreign catches significantly.

The Government is also prepared to require the submission of detailed plans by Canadian fishermen taking part in the short-term experimental projects in order to monitor all joint ventures and ensure that the interests of the Canadian fishing industry are protected.

LeBlanc expressed concern that even the present small-scale joint ventures were causing tensions between different elements of the industry and among different regions. Finally, he emphasized that in the future, joint ventures in the fishing industry would be tolerated only if they fit into the goals of overall fisheries planning and if they serve primarily as data gathering tools.

Libyan Fisheries Development Noted

The Government of Libya has established a Nutrition Council under the Ministry of State for Nutrition and Marine Resources with the responsibility of developing marine fisheries. This was done to stress the importance the Government attaches to the food and marine resources sector within the 1976-80 "Transformation Plan." In 1976, the fisheries program was allocated 8.8 million Libyan Dinars (US$2.6 million) of which only a small portion—250,000 L Dinars—was spent during the first quarter of the year.

The fisheries program provides for the construction of two ports (at Zuara and at Karsa), to complement the existing smaller ports. The program also provides for the completion of fishing ports at Khoms, Tripoli, and Janzour; and for additional piers in several ports. The Government also plans to construct fish canneries at Janzour, Khoms, and Zuara, and to install tuna-processing lines in the canneries at Zuara and Khoms. Icemaking and cold-storage plants in Tripoli, Sirte, Soussa, Talmeitha, Ein Al-Ghazala, Derna, Tobruk, and Sabratha have been finished and are run by the State.

The preliminary estimates of available fishery resources off the coast of eastern Libya have been completed; studies on species available in the territorial waters[1] were also done.

The Plan has provisions for the establishment of three joint ventures (with Yemen, Spain, and Malta) and for cooperation with Japan and Italy on an aquacultural project. A joint venture with Spain, named "Compagnie hispano-libyenne de peche," has already been formed. Five Arab banks have loaned US$7 million to this company for purchasing two fishing trawlers, at a total cost of US$15 million. The trawlers will be built in Spain. (Source: IFR 76/273.)

According to the NMFS International Fisheries Analysis Branch, the Nutrition Council had approved on 16 September 1975, a project to build seven small fishing ports at Abu Kamash, Marsa, Zuagha, Sabratha, Ein el Ghazala, Sirte, Zureik, and Tobruk. The "Ivan Milutinovic" company of Yugoslavia appears to have concluded the contract for the construction of these ports, with a preliminary estimated cost of $12 million. The same company is presently working on the construction of a large port at Misurata (estimated cost is $57 million) which will be completed this year and will be linked by railroad to Chad.

[1]Libya claims 12 territorial miles, but in the Gulf of Sirte 300 miles are claimed.

According to the Libyan Department of Marine Resources, at the end of 1975, a total of 1,388 fishermen were registered in Libya, of which 831 were Libyans. In addition, Libya had 562 fishing vessels (14.5 m long) and 14 trawlers (from 18 to 22 m long). The per capita consumption of fishery products was estimated at 3.5 kg.

Morocco's Shrimp and Lobster Fisheries[1]

SHRIMP

Shrimp is Morocco's most important crustacean resource, but the country has not yet established a significant shrimp fishery. Only one shrimp trawler is registered in Morocco and that vessel is operated by an Italian joint venture. The rest of Morocco's shrimp catch is incidental to bottomfish catches.

Many shrimp species are found in Morocco's waters (Fig. 1), but only two are commercially important: deepwater pink shrimp, *Parapenaeus longirostris*, called "crevette rose" (Fig. 2); and giant red shrimp, *Aristemorpha foliacea*, called "crevette rouge" or "crevette royale," (Fig. 3).

Catch

According to landing statistics provided by the Moroccan National Fisheries Office, ONP, Morocco's shrimp catch has decreased significantly since 1964 (Table 1). The shrimp catches decreased suddenly in 1964 and have remained low ever since for two reasons: 1) In 1964 the French shrimp fleet withdrew abruptly from Morocco's waters, and 2) many Moroccan fishermen are reportedly

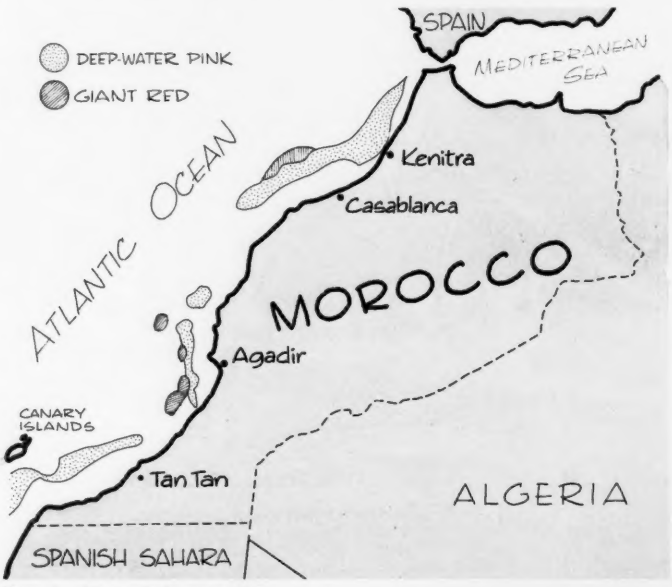


Figure 1.—Morocco's deepwater pink shrimp, *Parapenaeus longirostris*, and giant red shrimp, *Aristemorpha foliacea*, fishing grounds.

Table 1.—Morocco's shrimp catch, 1958-75, in metric tons.

Year	Catch	Year	Catch
1958	939	1967	543
1959	1,047	1968	258
1960	1,841	1969	205
1961	1,378	1970	528
1962	1,545	1971	291
1963	1,177	1972	291
1964	1,363	1973	134
1965	741	1974	131
1966	240	1975	303

Source: ONP, unpublished statistical data.

[1]This report was prepared by the International Fisheries Analysis Branch, Office of International Fisheries, National Marine Fisheries Service, NOAA, as IFR-77/31 and 77/36. It is based on reports and photos submitted by William B. Folsom, U.S. Regional Fisheries Attache for Africa, Casablanca, Morocco.

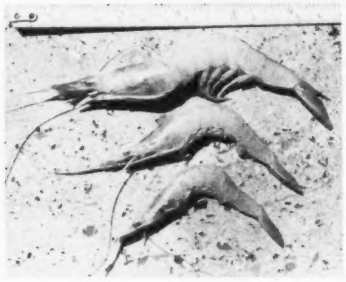


Figure 2.—Morocco's deepwater pink shrimp, *Parapenaeus longirostris*.

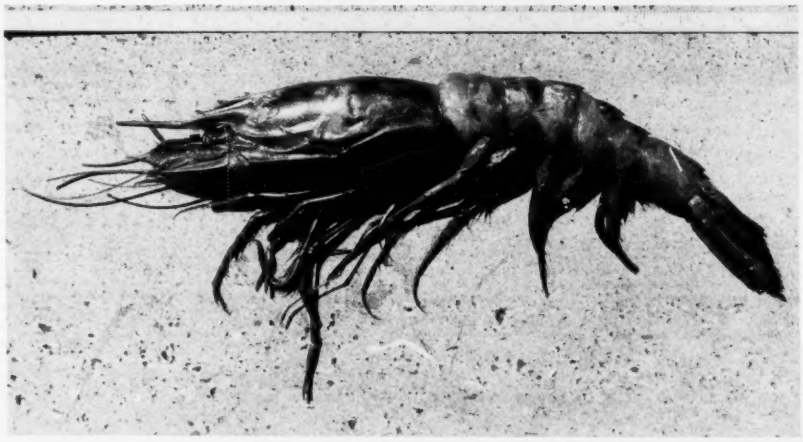


Figure 3.—The giant red shrimp, *Aristemorpha foliacea*, measures almost 15 inches from tip to tail.

Giant red shrimp and deepwater pink shrimp.

Figure 4.—A "langouste," *Palinurus elephas,* and a "homard," *Homarus vulgaris,* awaiting air shipment to Paris. Polystyrene boxes used for shipping live lobsters are stacked in the background.

selling their incidental shrimp catches to Spanish vessels on the high seas rather than bringing them into Moroccan ports.

The Spaniards pay more for the shrimp than the Moroccan fishermen can receive at the domestic wholesale auction market. Although shrimp brings high prices in Morocco, most fishermen still consider it an incidental catch and do not concentrate on its harvest.

Grounds

Most of Morocco's shrimp is caught less than a kilometer from the coast. Some shrimp, however, is caught further offshore in relatively shallow waters by large trawlers. The ONP, together with the UNDP/FAO, has conducted exploratory fishing for shrimp and reportedly found several large deepwater shrimp stocks at depths of from 400 to 800 m. No Moroccan vessels are capable of fishing that deep.

Morocco's shrimp is caught almost entirely along the Atlantic coastline. Most of the shrimp is landed in the two ports of Casablanca and Agadir. In 1975, nearly 290 t, or 92 percent of the total catch was landed in those two ports (Table 2).

Morocco's shrimp grounds are located mainly off Casablanca and Kenitra. Small stocks are also found off Agadir. The large southern resource of deepwater pink shrimp off Tan Tan is not currently being fished commercially. Additional shrimp stocks may also exist off the coast of the northern portion of the former Spanish Sahara which Morocco has annexed.

Joint Ventures

An Italian joint venture to fish for shrimp and squid, ARMIPECHE, was reportedly established in July 1976. The Italian partner is the FRESCOGEL company of Milan. The joint venture's initial capitalization was $412,500. The company has a 43-m trawler, the *Ain Leuh,* which was built in Italy and has a 200-m^3 hold, carries 18 crewmen, and can make voyages of up to 45 days.

Table 2.—Morocco's shrimp catch, by port, 1974-75.

	Catch (t)	
Port	1974	1975
Al Hoceima	0.2	1.0
Tangier	2.3	5.0
Larache/Acilah	3.4	2.4
Kenitra	4.5	14.0
Casablanca	58.4	133.8
El Jadida	—	0.1
Safi	17.2	—
Essaouira	0.2	0.1
Agadir	44.4	146.2
Total	130.6	302.6

Source: ONP, unpublished statistical data.

Prospects

Morocco's offshore shrimp resource could be expanded to at least the pre-1964 catch levels by the use of modern shrimp trawlers. Additional shrimp catches at depths of 400-800 m could result in even greater catches. No studies presently available, however, show the actual size and locations of the resource, the species available, or their migration patterns. Shrimp fishing with modern deepwater shrimp trawlers remains an attractive, but so far undeveloped, fishery.

LOBSTERS

Morocco's rocky Atlantic and Mediterranean coastline has traditionally provided sanctuary for three species of lobster: the Norway lobster, *Nephrops norvegicus,* called "langoustine" by the Moroccans; the European lobster, *Homarus vulgaris,* called "homard" (Fig. 4); and the European spiny lobster, *Palinurus elephas,* called "langouste". A fourth species, the "green lobster", *P. mauritanicus,* is known to exist in sizeable quantities off Mauritania and most likely also off the

Table 3.—The Moroccan lobster catch in kilograms, by species and port, 1974 and 75.

Port and year	Species: European lobster	Spiny lobster	Norway lobster	Total
Nador				
1974	—	6,735	9,902	16,637
1975	—	—	22,827	22,827
Al Hoceima				
1974	—	180	180	360
1975	—	—	125	125
Larache				
1974	41	5,673	40	6,424
1975	3,550	3,530	—	7,080
Mohammedia				
1974	1,286	4,604	393	6,283
1975	1,060	2,895	673	4,628
Casablanca				
1974	5,043	5,621	44	10,708
1975	5,876	4,477	45	10,398
El Jadida				
1974	—	—	—	—
1975	—	3	—	3
Safi				
1974	4,144	3,806	19,598	27,548
1975	8,583	11,395	46,448	66,426
Essaouira				
1974	6,872	5,788	1,299	12,959
1975	8,623	21,555	5,995	36,173
Agadir				
1974	690	715	—	1,405
1975	4,429	6,417	446	11,292
Total				
1974	18,076	33,122	32,126	83,324
1975	38,121	50,390	76,559	165,070

Source: ONP, unpublished statistical data

Table 4.—Moroccan lobster exports, by commodity, quantity, and value, 1973.

Commodity	Quantity: kg	lb	Value: Dirhams	Dir/kg	US$[1]	$/lb
Lobster						
Tails	451	994	15,120	33.53	3,780	3.80
Live	47,827	92,211	1,297,150	31.01	324,288	3.52
Whole, other	2,687	5,923	59,690	22.21	14,923	2.52
Whole, nes.	305	672	9,030	29.60	2,258	3.36
Spiny Lobster						
Whole	103,681	228,575	3,882,260	37.44	970,565	4.25
Total	154,951	328,375	5,263,250		1,315,814	

[1]Calculated at the exchange rate of 4 dirhams for US$1.00 prevailing in September 1976.
Source: Ministère des Finances, *Statistiques du Commerce Exterieur*, Office des Changes, Royaume du Maroc, 1974.

former Spanish Sahara[2]. Green lobsters are not presently being harvested by Moroccan fishermen.

Fishing Regulations and Gear

Lobster is harvested from February through September. Fishing is prohibited from 1 October to 1 February. The taking of roe-bearing females is officially prohibited, but this regulation is not always strictly observed.

Morocco's lobster fisheries are somewhat primitive; one or two men operate from a rowboat or a sailboat close to shore. Baited wooden traps are usually set to catch the lobster.

Catch

Statistics provided by the National Fisheries Office (ONP), show Morocco's European lobster catch averaged 20 t per year during 1958-75. The Norway lobster catch has averaged 11 t annually. The catch of spiny lobsters has averaged 29 t per year, but this high average is due to an unusually large catch of 109 t in 1962; otherwise the catch has been closer to 20 t per year. There has been a general increase in lobster landings during the last 2 years (Table 3).

There has been a growing interest in deepwater lobster fishing in Morocco during the past few years, and it will probably be only a matter of time before deepwater fishing begins. Negotiations between a Moroccan company and a U.S. shipyard over the purchase of steel-hulled lobster vessels have already taken place.

Domestic Market

Landed lobsters are usually penned in enclosures until they are picked up. Firms specializing in lobster marketing send trucks up and down Morocco's long coastline; they stop in small fishing villages along the coast to buy lobsters. These lobsters are then taken to the major cities where they are sold live.

Although lobster fishing remains underdeveloped, Moroccan fishermen easily sell their catch. There is a good demand for live lobsters in Morocco and a tremendous demand for Moroccan lobsters in France and Spain. As a result, lobster prices are high: $3.50/lb for "homards" and $4.50/lb for "langouste" are common in Moroccan retail stores and it is not at all uncommon to find live lobsters selling for $20.00 apiece in a fancy Casablanca seafood restaurant.

Exports

The export markets contribute both to the high prices of lobsters locally and to the general absence of lobsters on the local markets. Morocco's lobster exports for calendar year 1973 are shown in Table 4.

Moroccan International Fishery Relations and Joint Ventures Told

The Regional Fishery Attache for Africa, William B. Folsom, has prepared two reports on Moroccan fisheries. The first describes Morocco's international fishery relations. Folsom reports that Morocco's fisheries policy is founded on two principles: 1) the protection of Morocco's marine resources for the benefit of Moroccan citizens; and 2) the need to obtain foreign technology and capital to help develop these resources. The Moroccan Government's efforts to promote these goals through fishery agreements with France, Mauritania, Portugal, the Republic of Korea, the Soviet Union, and Spain are detailed in Folsom's report.

The second report describes Morocco's policy of promoting joint fishery ventures with foreign companies. One of the responsibilities of Morocco's Office National des Pèches is to encourage foreign fishery investments. Existing and planned joint ventures with Japan, France, the Republic of Korea, Italy, Denmark, and the United States are described.

A copy of either, or both, of these reports can be obtained by requesting the desired report(s), attached to IFR 77/65, from the International Fisheries Analysis Branch, NMFS, NOAA, Department of Commerce, Washington, DC 20235. Please specify the title of the report requested.

[2]Mauritania obtained in the southern part of the former Spanish Sahara when that colony was partitioned between Morocco and Mauritania in 1975. The Mauritanian lobster fishery is described in Foreign Fisheries Leaflet 76-3, "The Fisheries of Mauritania", which is available from D825, Environmental Science Information Center, NOAA, U.S. Department of Commerce, Washington, DC 20235.

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